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EXPLOSION ON OIL-TANK STEAMER PROGRESSO.

On the morning of December 4 the steamer *Progresso* was lying at the wharf of the Fulton Engineering and Shipbuilding Works, San Francisco, where she had been for about six months while being converted from a coal-burning coal carrier into an oil-burning oil carrier. The repairs, which were nearing completion, included an installation of new boilers and engines, and a thorough overhauling to equip her to ply in the oil-carrying trade between Philadelphia and Texas ports. Men were at work putting the finishing touches on the new cargo tanks, while the engine- and boiler-room force were getting the new burners into operation preparatory to running the trial trip the day following. The steam on the boilers had reached between 30 and 40 pounds. The only oil on board was about 400 barrels in the fuel-oil tank, which was built to carry 1,940 barrels.

THE OIL TANK STEAMER PROGRESSO BURNING AT THE DOCK, SAN FRANCISCO.

Without an instant of warning a violent explosion broke the steamer squarely in two, forced up the deck amidships, and tore and twisted the steel plates of the hull as though they were made of tin. Within a few minutes the ship was enveloped in dense clouds of black smoke that soon burst into flame, while burning oil ran out of the hull and blazed up on the surface of the water for a considerable distance on all sides. Fourteen men were killed outright and about the same number found their way to various hospitals. The scenes that followed the explosion were heartrending in the extreme. The ship was moored eight or ten feet from the wharf of the works, just under the shear legs. Many of those that made their escape covered the distance from the deck to the dock by blinded leaps, while others slid down ropes or sprang into the water to be immediately surrounded by the burning oil. Several of those killed were blown from the ship's hull out into the water and their bodies eventually recovered 100 feet or so from the ship's side.

The plant of the Fulton Engineering Works is located

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near the far-famed Presidio, and at the time of the explosion the field battery of the First Artillery, as well as several other detachments of soldiers, were engaged in regular morning drill. They were immediately ordered to the scene and were the first to drag the injured away from their perilous positions, and saved the ship's papers, as well as other effects that could be carried off. They policed the works and held sway until the later arrival of the police and fire departments of the city, who had been called on general alarm, but were unable to reach such an out-of-the-way place in good time. Regardless of tons of water that were poured into the hull all day long, the big tank steamer became a seething, roaring furnace, and for a time threatened the safety of the wharf and of the iron works. The fire had to burn itself out. The following day, when it was possible to make an examination, it was found that the ship was a total loss, the disaster involving between $200,000 and $250,000.

FIRE BOATS AT THE BURNING OF THE TANK STEAMER PROGRESSO.

From the illustration of the tank arrangement, shown herewith, it will be seen that there were five *cargo* oil tanks and one *fuel* oil tank. These were separated from the boiler and engine-room space by a water cofferdam three feet thick fore and aft, as well as ten feet of air space. As noted before, the only oil on board consisted of about 400 barrels in the fuel-oil tank. The only outlet to this tank was to the deck above, and this was covered by a manhole plate, which was blown by the explosion forward amongst the rest of the débris.

In the incipient experiences with a new fuel more or less trouble may be expected. But crude petroleum, like the heavy oils of the Kern river field, has been used by the Baku oil carriers on the Black Sea for twenty years or more, and we have yet to learn of the first accident occurring to any of that fleet. There are 250 manufacturing plants in San Francisco and over 100 vessels sailing from that port using crude petroleum with equal security. The various investigations that have been started by those interested in this matter promise to divulge many things about fuel oil which are not yet a matter of record, and they may or may not determine the cause of this explosion. So far it remains as complete a mystery as the day it occurred.

Nearly all cities where crude petroleum is used for a fuel have an ordinance providing that no oil may be used or exposed for sale if it flashes below a prescribed minimum temperature. The lowest temperature fixed in any State or municipality is 110 degrees Fahrenheit, and this temperature was accepted by the Board of Supervisors of San Francisco when they provided that,—

"No crude petroleum or any of its products, or any oils or fluids, shall be used for fuel, cooking, heating, or illuminating purposes within the city and county of San Francisco, unless that same will stand a fire test of 110 degrees Fahrenheit, or better, before it will flash or emit an inflammable vapor. No person or persons, firm, company, or corporation shall *mix, adulterate,* or offer for sale any oils used for heating or illuminating purposes, with benzine, naphtha, gasoline, or any other substance; and all oils or fluids manufactured from petroleum or any of its products, to be used for heating

PORT SIDE OF THE PROGRESSO, BLOWN OUT BY THE EXPLOSION.

THE WRECKED PROGRESSO. THE MEN IN THE BOAT ARE DRAGGING FOR BODIES.

or illuminating purposes, shall be required to stand a fire test of 110 degrees Fahrenheit, or better, before it shall flash or emit an inflammable vapor."

The owners of the ill-fated *Progresso* secured permission from the Secretary of the Treasury of the United States to burn oil upon submitting a plan of the vessel for his inspection. The law governing the granting of such a permit is as follows:

"The Secretary of the Treasury may permit the use of petroleum as fuel on steamers not carrying passengers, without the certificate of the supervising inspector of the district where the vessel is to be used, subject to such conditions and safeguards as the Secretary of the Treasury, in his judgment, may provide."

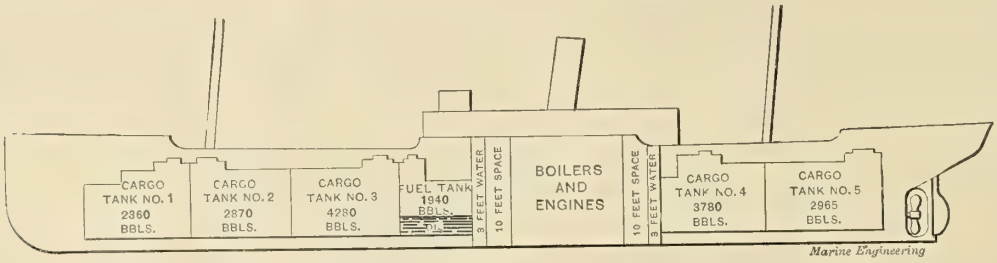
Though not compulsory, as shown by the law cited, it is understood that the owners of the *Progresso* submitted their plans to the supervising inspector of the district and secured his approval, as well as that of the Secretary of the Treasury.

It may be interesting to note the experience of one of the men who were below at the time of the explosion, and who is credited with a most miraculous escape. He says: "—— and myself were the only persons in the after fire room when the explosion took place. I was stooping down, looking up under the ash-pan damper of the center furnace of the after boiler, when I felt a shock that threw me forward and stunned me for a moment. I knew it was an explosion, but was not sure until later as to just what had happened. I can say, positively, that the cause of the explosion did not lie in the oil burners, which were working splendidly. We did not see any one as we left the after fire room, and I think there was no one else in that particular portion of the ship. It was a hard struggle for us to reach the upper deck because of the dense smoke and the darkness that enshrouded everything. We climbed up some sort of a companionway in the dark and from there made our way around the boilers and on up until we could see the light. It was a severe test on our endurance, for at every step we were breathing the heavy gas-laden air."

The *Progresso*, formerly the *Wells City*, was built at Sunderland, England, in 1885. Her dimensions were: length, 270 feet; beam, 36 feet; and depth, 23.5 feet. She had a gross tonnage of 1,919 and a net tonnage of 1,445. After her transfer to the American flag she was registered in New York under her new name. She was formerly owned by the Progresso Steamship Company, and was valued at about $200,000.

The problem that confronts the Fulton Engineering Works is the removal of the mass of wreckage which occupies the most important part of the shipyard frontage. It is thought that it will be possible to erect temporary bulkheads for each half of the ship, and, after cutting away the portion remaining between these two divisions, float each section independently of the other.

Steamer Monroe.—The Newport News Shipbuilding and Dry-dock Company, Newport News, Va., launched on October 18 the passenger and freight steamer *Monroe*, which is intended for the New York and Norfolk service of the Old Dominion Steamship Company. The dimensions of the vessel are as follows: Length over all, 366 feet; between perpendiculars, 344 feet; beam, molded, 46 feet; depth, molded, 37 feet; draft, 18 feet; displacement, 5,375 tons. Accommodations are furnished for 122 first-class passengers (white), 22 first-class passengers (colored), 78 steerage passengers, 57 deck passengers, and officers and crew of 81. The vessel will be driven at a speed of fifteen knots by a vertical triple-expansion engine of about 4,500 I.H.P.


CARGO TANK NO. 1 2360 BBLS.
CARGO TANK NO. 2 2870 BBLS.
CARGO TANK NO. 3 4280 BBLS.
FUEL TANK 1940 BBLS. OIL
3 FEET WATER
10 FEET SPACE
BOILERS AND ENGINES
10 FEET SPACE
3 FEET WATER
CARGO TANK NO. 4 3780 BBLS.
CARGO TANK NO. 5 2965 BBLS.
Marine Engineering

ARRANGEMENT OF CARGO AND FUEL-OIL TANKS, STEAMER PROGRESSO.

MEMORANDA REGARDING FUEL OIL ABOARD SHIP.

BY WALTER J. GOODENOUGH.

It is hoped by the writer that the remarks contained in this article will be taken largely as suggestions, and that others interested in fuel oil for marine purposes will take occasion to criticise them through the columns of MARINE ENGINEERING, in the desire that much fruitful discussion will ensue, such discussion at the present time being of considerable benefit to vessel interests.

At the moment this subject is of much importance to shipbuilders and shipowners. Not so much because of the advantages of cheap fuel for certain localities, but because of the sudden desire and intention of placing upon vessels a new and somewhat untried device. This carries with it the dangers resulting from all such arrangements; and to minimize these dangers and afford a basis for insurance, Lloyds have in a circular letter to their surveyors conveyed certain directions regarding the installation of bunker tanks and burning apparatus in vessels which have previously been used otherwise than for the carrying or burning of oil. Lloyds' letter, then, becomes one recognition of the seriousness of the problem, and is all the more significant owing to the vast interests which they represent and protect. The Bureau Veritas has long recognized that oil-tank steam-

ers form a class by themselves, and that they require special rules for their construction. They began first to give these vessels their attention and assistance at a very early period, and have continuously aided owners, underwriters, and shipbuilders in their efforts to obtain safe, insurable vessels. To meet the increasing business of this kind in the United States, where most of the "lines" on oil cargoes are carried, the United States Standard Steamship Owners', Builders', and Underwriters' Association, Ltd., is preparing a set of rules for the construction of oil-tank vessels and their machinery. It is expected that these rules, which are to be very complete in character, will appear shortly.

BUNKERS.

The position of the fuel-oil bunkers is a first problem of design. It has been the practice in some vessels to use the double bottom and peak tanks for the storage of oil, even in vessels where the cargo is oil in bulk. While this practice is in many cases necessary, it must be pointed out that it entails a considerable danger owing to the extremely confined spaces and to the original light riveting and construction employed. In the ordinary construction of vessels it is usual to slight such portions of the work as are inconvenient to get at by the workman, and it is just in these places (water bottom and peaks) where the slighting is the greatest. When oil is placed in such compartments it speedily shows that the makeshifts for procuring water-tightness are of no avail. Again, adequate examination and cleaning of these tanks is extremely dangerous to life and to property. The heavy gases confined in small, close spaces, prevented by the nature of the construction of the vessels from circulating freely, stand ready to suffocate the luckless surveyor or cleaner, or to destroy the vessel in an instant should a spark be present.

Supposing, however, double bottoms and peak tanks to be the only places available for the storage of fuel oil, its storage should not be countenanced in tanks in way of the fire and engine rooms. This does not agree with Lloyds' letter where it states: "Arrangements for carrying astaki oil fuel in cofferdam between the boiler space and the petroleum tanks, in double bottoms, and in the fore and after peak tanks have been approved." I believe, however, that it is the opinion of the men who have to inspect these vessels that the danger is too excessive to be permitted to stand. Imagine a vessel striking an obstruction in way of boiler room double bottom, forcing up floors and opening seams of tank top, permitting the oil, buoyed up by the water pressure due to vessel's draft, to enter the fire room, generate gas and ignite the same. This might easily be the occurrence where the damage due to grounding was merely insignificant. In the same way consider the tanks at the sides of the boilers, and that the vessel receives some of the ordinary blows given in warping to dock or by lighters.

The practice of carrying oil in the cofferdam would seem without logic. We might as well say immediately that oil will prevent oil from entering the fire room in the case of leakage.

It may be said that the question of whether the shipbuilder and the shipowner make money or not will depend largely upon the excellence of workmanship in the construction of tanks. The requirements for testing such tanks are rightly severe, and the cost of correcting defects in this class of vessel is much greater in proportion than for ordinary ships. In oil-tight work the makeshifts of felting and red lead are only temporary in their assistance, and in the places where it is customary to use them it is most difficult and expensive to repair the damage when they have given way. The value of rigid testing should not be under-estimated, as the heaviest static pressure tests now used are far from representing the forces hurled against shell, deck, and bulkhead when the vessel is in a seaway and the cargo and the oil of the partly-filled bunkers exert the force due to their inertia.

A desirable form of bunker is one of large capacity, narrow in proportion to its height, offering thereby the least free surface and affording such a quantity of oil that suctions do not require to be changed often; of such depth that the entrance to the suction can be well above the bottom of bunker, insuring greater freedom from dirt and water. All bunker tanks should have easy means of access for the inevitable and frequent cleaning. It is also apparent that all bunkers, where possible, should be built into the ship. To place separate bunkers in a vessel is to create spaces between them and the hull for the collection of gases, and to prevent obtaining in the fullest degree proper and adequate ventilation.

VENTILATION.

The ventilation of all confined spaces, in tanks or outside, where gases may collect, is by no means as easy as it appears. These gases are heavy. To put a ventilator to the top of the compartment and there stop is simply to change the air immediately above the stratum of gas, and that stratum gradually becomes thicker as the oil recedes, leaving the wetted surfaces and volume of gas to increase. To carry the ventilator nearer the bottom of the space is to stir the gas by the inrush of air, but the gas will not depart, because it is heavy, and as the tank is air-tight it would produce a vacuum should the gas endeavor to get out by the one ventilator. A current must be established. There should be an inlet at the top to supply air, and an outlet somewhat lower to remove the mixture of air and gas. As the direction of air currents in a ship is invariably from aft forward, the inlet will be aft and the outlet forward. To assist further, the inlet will be a cowl ventilator, and the outlet an induction ventilator. Complicated and expensive as such a system appears, yet, properly installed, it does its work without attention or repair until the vessel has ceased her service. The tops of all ventilators should be carried well up into the air and away from close proximity to house or other deck erections. No oil-tight tank should be permitted to be without means for allowing air to enter at any time. Lack of such provisions has been known to bring down decks or spring bulkheads.

Electric-driven fans used for clearing holds of gases should have the motors carefully isolated in a tight compartment where there is no possibility of gas entering to be ignited by a spark from the commutator.

It has been often suggested that plugs or manhole plates should be fitted in the bottom of oil compartments for the escape of gas. While it can undoubtedly be safely and securely done, yet the times when such devices can be used are the infrequent times when the vessel is in

dry-dock; so that the ship would derive, in the ordinary course of running, but little benefit.

PIPING.

As in the construction of oil work, the piping requires the acme of careful fitting. As near as possible, when screwed joints are used in the suction and deliveries of oil pumps, the work should be a metal-to-metal fit. Where any jointing is used at all, it should be allowed to remain undisturbed until it is very hard, otherwise the oil washes it away from the joint. A very good pipe cement for oil work is made of litharge and glycerine, also a mixture of Venetian red and shellac. The use of rubber or compositions containing rubber for flange jointing is not good practice, owing to the very rapid deterioration of such materials in contact with petroleum.

Before any pipe carrying oil to burners is put up it should be carefully hammered to loosen all scale and dirt on the inside of the pipe. As nearly every form of burner has a very small orifice for the oil, they are easily clogged, which necessitates taking the burner apart. This operation reduces temporarily the amount of steam evaporated by the boilers, and amounts in some instances to throwing one furnace out of commission.

In laying the suction pipes, care should be taken that, under any ordinary list or trim of the vessel, gas pockets be not formed at high points in the pipe. Should a thoroughly good gas pocket be obtained, it will be very hard to overcome, and in the meantime the effect will have been felt at the burners and on the boilers. A sudden decrease in the amount of oil, without the same decrease of air, means an excess of cold air and a cooling of the boiler.

Any crude oil has a large amount of foreign matter in the form of dirt, sticks, bits of waste, etc. It is to be recommended that no suction-pipe to fuel-oil pumps be fitted with a rose or strainer in the tank, but that approved strainers in duplicate, with by-pass to both, be fitted near the pump. This arrangement always leaves one to be cleaned while the other is in operation. The placing of strainers in the tanks is undesirable, as it leaves the engineer powerless in case they become stopped up, because he cannot enter that tank to make repairs while it contains oil. It is a nice precaution, however, to have all suction lines so arranged that they may be blown through into the tanks by an oil or water pressure.

The practice of running delivery pipes under the fireroom floor to the burners has little to recommend it. Oil-pressure pipes are specially subject to leakage, and were better placed above the floors, where they can be properly looked after. The necessity of keeping pipes clear of coal and ashes is gone when oil is burned, and there is, therefore, no good reason for putting pipes in the bilge.

ELECTRIC LIGHT.

The same care is to be taken in the wiring of the vessel to prevent ignition of gases by sparks, as is taken in other directions. Wiring on the two-wire system; careful insulation, and insulation not affected by petroleum; care in location of switches, junction boxes, and cut-outs; and outside air-tight globes over lights, are some of the more important points to be secured.

FURNACE CONSTRUCTION.

Heat is the result of combustion of any fuel; its intensity is due to the rate, and how, when, and where air is admitted into the combustion chamber. Its condition when admitted governs the possibility of its effective mixture with the oil vapor and its complete combustion. It too often happens that complete combustion is impaired, not from the lack of air, but on account of the method of its introduction into the furnace. Any effort, then, on the part of the operator to increase the rate of combustion results in smoke, without raising the temperature of the furnace gases, notwithstanding the fact that there may be introduced many cubic feet of air in excess of that necessary for perfect combustion. For each and every atom of air thus admitted into the combustion chamber in excess of the actual requirements, there must also be introduced a sufficient amount of oil to raise the excess air to the temperature of the furnace before any heat is given off. Excess air results in a waste of fuel and a loss in economy. If more air is supplied during the time that a pound of fuel is burned, the excess must pass through the furnace without performing any service, and in its escape to the chimney carries away 0.2375 of a heat unit for each pound raised one degree in temperature. Therefore, for economic reasons, no more air should be supplied than is necessary.

During the early stages of combustion of any fuel the gases of a highly volatile nature distil at a low temperature, rise rapidly, hug the boiler, enter the tubes or flues, and pass out through the breeching unconsumed. The combustion chamber of the boiler should, therefore, be arranged with firebrick, so that the incoming air may be heated to the required temperature, that the flames may be retarded, diffused, and distributed, and their velocity impeded. Then there will be no concentration or localization, and the danger of burning or blistering any part of the boiler is avoided. Therefore, the statement is not unreasonable *that a scientifically-arranged combustion chamber, with a shovel to feed the oil, is far more to be preferred than a poorly-constructed furnace to which is attached the highest type of atomizing device.*

Thus the matter of furnace design becomes one for the engineer, and not the inventor, and each furnace of a type must have consideration separate from any other one. The great difficulty to be overcome in a Scotch boiler burning oil is to secure a large enough volume in the furnace to properly mix the air with the vapor of oil and thoroughly complete combustion. For this reason it is advisable, in order to obtain the full benefit from the fuel, to remove all grate bars and provide means of utilizing the entire furnace volume.

When using steam or compressed air as an atomizing agent, it is usually desirable to cover the back plate of the combustion chamber with firebrick. The velocity of the issuing steam or heavy-pressure air is so great that in our comparatively short Scotch boilers it would throw the flame heavily against the metal, cooling the flame, reducing combustion, and overheating the plate. In all cases, however, the riveted seams at the rear of the furnaces should be covered with a refractory material, and the furnace shell above the bridge should be covered with firebrick to prevent any direct impinging upon the metal, and to assist in the combustion by heating the air and gases.

FUEL-OIL TUGBOAT SEA ROVER.

The ocean-going steel tug *Sea Rover* has recently been added to the fleet of the Ship Owners' and Merchants' Tugboat Company, of San Francisco. She was built and engined by the Fulton Engineering Works, at Harbor View, San Francisco, and is of dimensions given in the data table on page 10.

The boat was originally planned as a coal burner, with side bunkers and large thwartship bunkers forward of the boiler room and between the engine and boiler rooms; but the general introduction of oil fuel on the Pacific coast caused the owners to have the plans modified and provision made for carrying the greatest amount of fuel oil. The oil is carried in four compartments, as is shown on the general plan, and each tank, except the fore peak, has a center line bulkhead and other swash bulkheads to insure strength and stability. The oil tanks have a total capacity of 53,400 gallons, which will give twenty days' steaming at full power.

The transverse oil-tight bulkheads consist of 3-8 and 5-16-inch plating, with both vertical and horizontal stiffeners connected to shell and deck plating with plate brackets. All seams and butts are lapped and double-riveted, and a single double-riveted bounding angle connects bulkhead to shell and deck plating.

The deck house is built of steel and contains the usual accommodations of sea-going tugs. The partitions are mostly of light steel plate covered with cork paint. The captain's room and pilot house are built of Oregon pine, with oak finish inside. The main tow bitts are of cast iron and are located between the deck house and the hood or skylight over the main engine, thus placing them well forward and in a fine position for towing. The top of the skylight over the main engine is built in four sections, bolted together, and has four hinges on the forward end by which it may be lifted as a whole when necessary to overhaul the engine, or any section may be removed as required.

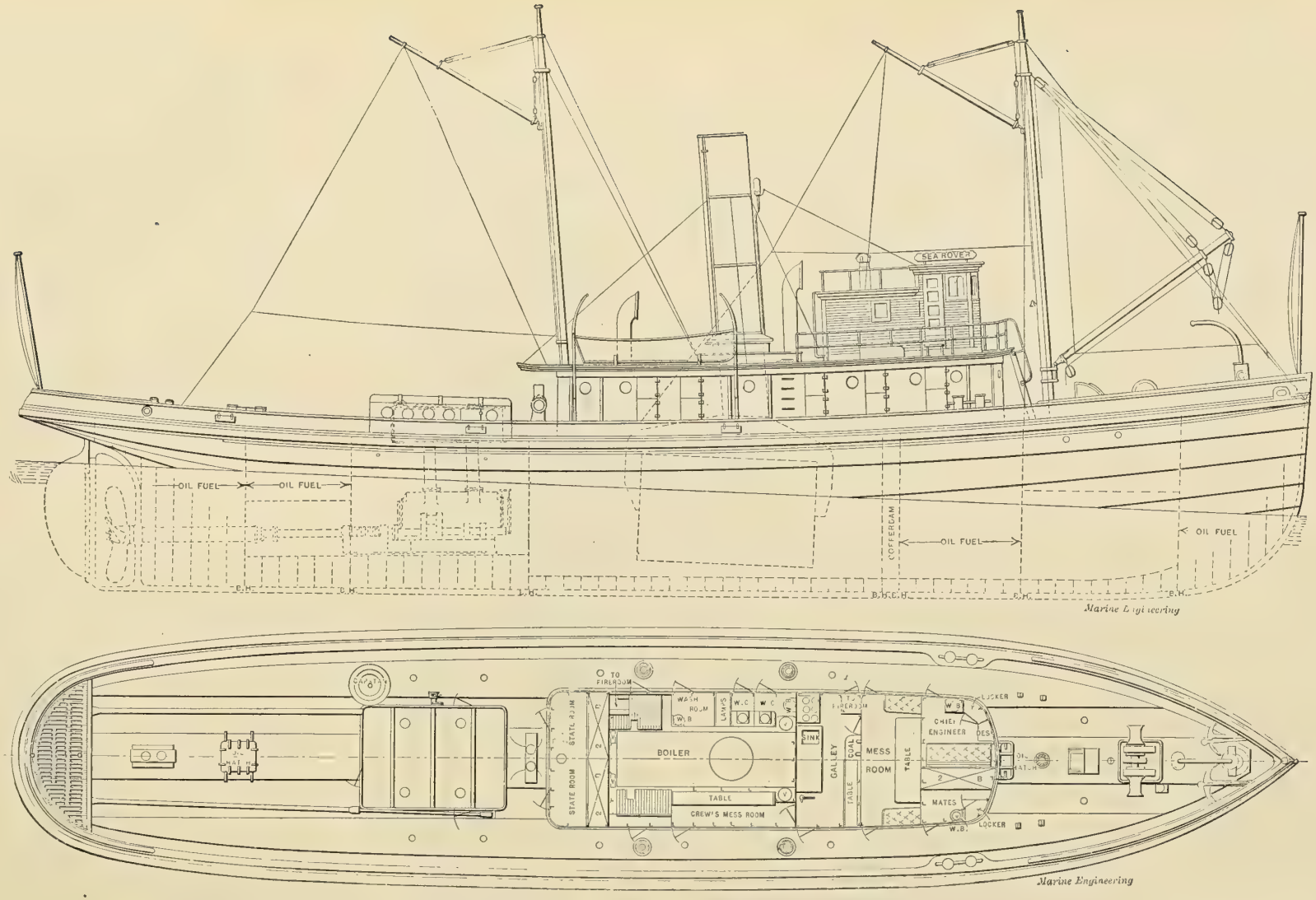
There is a large forecastle forward below the main deck for the crew, with store room and chain lockers below. A fore-and-aft bulkhead on each side of the boiler extends the full length of the boiler-room space, thus forming two side bunkers, the after ends of which are used for fresh-water tanks. The air compressor is placed in the starboard bunker, and the port bunker is used as a store room.

TUGBOAT SEA ROVER, FITTED FOR BURNING OIL.

MACHINERY.

The main engine is of the vertical, inverted-cylinder, compound, marine type, built for a working pressure of 175 pounds per square inch. Other dimensions will be found in table. There are three steel front columns and two cast-iron back columns of box section, resting on the condenser, which thus forms part of the framing.

A steam piston valve is on the high-pressure cylinder, taking steam inside, and a double-ported slide valve is on the low-pressure, both steam chests being outside their respective cylinders and connected by a copper receiver pipe. The crosshead is of the locomotive type, with cast-iron guides of box section, cored out for water circulation. The crosshead slippers are of bronze with babbitted faces.



SAIL AND DECK PLANS OF THE OIL-BURNING TUGBOAT SEA ROVER, BUILT BY THE FULTON ENGINEERING COMPANY, SAN FRANCISCO, CAL.

Dished bull ring pistons are fitted, with steel piston rods secured in piston heads with taper and nut. The connecting rod is 70 inches long, with forked upper end and crosshead pin shrunk in, making the bearing in the crosshead. The lower end of the connecting rod is provided with Scotch brasses for the crank pins.

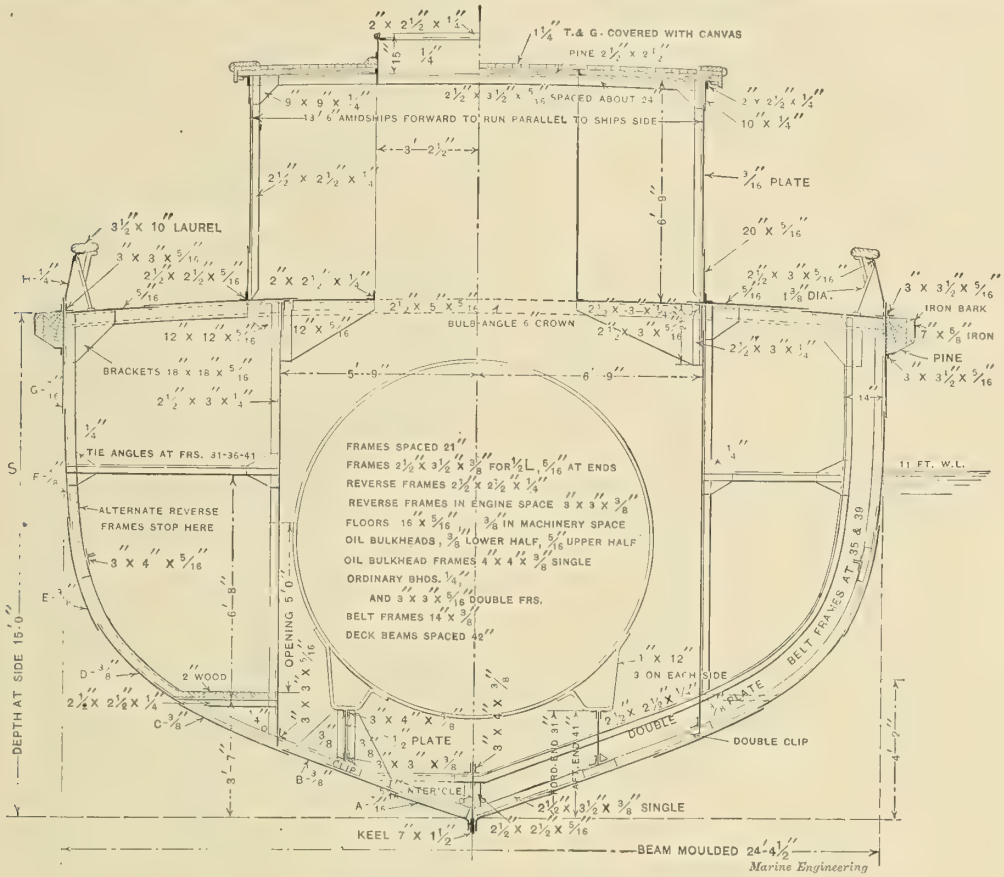
The reversing gear consists of the regular Stephenson link motion, with double-bar links and bronze block, operated by a steam cylinder secured to front of

main engine cylinders and connected directly to a lever on the reversing shaft below.

The crank shaft is of the built-up type, with cast-steel crank cheeks counterbalanced. Crank, thrust, and propeller shaft are each 9 inches diameter, the thrust shaft having seven collars forged on same for the thrust yokes, and the propeller shaft being provided with heavy composition liners where it rests in the stern and inboard bearings. The stern tube is of cast iron; the bearings at each end are of lignum vitæ, fitted into brass shells, which are fitted in the stern tube on a taper, to be readily removed when necessary. The propeller is of cast iron, with four blades.

A complete oil-burning plant is also installed, which will be described in detail later in this article.

Steam is supplied by one double-end Scotch marine boiler 10 feet 6 inches diameter by 16 feet 6 inches long, containing 384 3-inch tubes and four furnaces 36 inches diameter inside corrugations. The heating surface, computed on the basis of a coal burner and allowing dead space in furnace and combustion chamber, is 2,213 square feet. The boiler is built to comply with both Lloyds' and the United States rules. When oil is used as fuel and no grates or bridge walls placed in furnaces, the actual heating surface is much larger than ordinarily considered for coal fuel; for this, as


T.& G. COVERED WITH CANVAS
PINE
13' 6" AMIDSHIPS FORWARD TO RUN PARALLEL TO SHIPS SIDE
3/16 PLATE
20" X 5/16"
3½" X 10" LAUREL
IRON BARK
7" X 5/8" IRON
PINE
BULB ANGLE 6 CROWN
BRACKETS 18 X 18 X 5/16
TIE ANGLES AT FRS. 31-36-41
11 FT. W.L.
FRAMES SPACED 21"
FRAMES 2½" X 3½" X 3/8" FOR ½L, 5/16 AT ENDS
REVERSE FRAMES 2¼" X 2½" X ¼"
REVERSE FRAMES IN ENGINE SPACE 3" X 3" X 3/8"
FLOORS 16" X 5/16" 3/8 IN MACHINERY SPACE
OIL BULKHEADS, 3/8 LOWER HALF, 5/16 UPPER HALF
OIL BULKHEAD FRAMES 4" X 4" X 3/8" SINGLE
ORDINARY BHDS. ¼"
AND 3" X 3" X 5/16" DOUBLE FRS.
BELT FRAMES 14" X 3/8"
DECK BEAMS SPACED 42"
ALTERNATE REVERSE FRAMES STOP HERE
OPENING 5' 0"
DEPTH AT SIDE 15' 0"
2" WOOD
3" X 3" X 5/16"
3" X 4" X 5/16"
3" X 4" X 3/8"
3" X 3" X 3/8"
3" X ½" PLATE
1" X 12" 3 ON EACH SIDE
BELT FRAMES AT 0, 35 & 39
DOUBLE
DOUBLE CLIP
KEEL 7" X 1½"
2½" X 3½" X 3/8" SINGLE
2½" X 2½" X 5/16"
BEAM MOULDED 24'-4½"
Marine Engineering

MIDSHIP SECTION OF TUGBOAT SEA ROVER.

There are two feed pumps and one bilge pump, all worked with the air pump by beam from the low-pressure crosshead. The two feed pumps draw from the hot well direct and discharge to the main boiler.

There is a 6 by 6-inch engine direct connected to an 8-inch centrifugal pump; a 6 by 8-inch windlass forward, and a 5 by 7-inch steam capstan aft. The steam steering gear, as well as the above-mentioned auxiliaries, was designed and built by the Fulton Engineering Works, and consists of a 4 by 5-inch double-cylinder engine secured to the bulkhead in engine room, operated by the usual wheel in pilot house, the change from the steam gear to the hand gear being made by clutch levers in engine room. The fire pump in engine room may be used also for wrecking and general purposes. There is also one Worthington Admiralty-type donkey pump and a 4-K.W. direct-connected generating set, both located in engine room.

well as other reasons, when the change is made from coal to oil a marked increase of steam capacity is noticed.

This boiler, while it would probably be good for little over 700 I.H.P. with easy firing with coal, as an oil burner will produce steam with ease for 800 to 850 I.H.P.

FUEL-OIL SYSTEM.

The object sought for in installing this fuel-oil plant on the *Sea Rover* was to not only provide a thoroughly reliable and economical system, but, in view of the intermittent duties of a towboat, with its short runs and constant reversals, to make the plant as much as possible entirely automatic.

The two tanks over the shaft alley are used as settling tanks for removal of water, a gage glass and steam siphon being fitted for detecting and removing the water that settles and discharging it overboard. One

steam pump in the forward fire room draws from all the storage tanks and discharges into these settling tanks. A duplicate set of steam pumps are located in the after fire room, which draw from these settling tanks and feed the burners.

There are fitted, in he oil-suction pipe to these pumps, a duplicate set of strainers for removing dirt or any foreign matter which might cause trouble, and the oil on leaving the pumps passes into a heater where exhaust steam is used to raise its temperature to 160 degrees Fahrenheit. This oil heater is provided with a float mechanism, which controls the speed of the pumps by acting on a throttle valve in the steam pipe.

There is a duplex horizontal air compressor of the Fulton Giant type, with 7 and 12 by 12-inch cylinders, located in the starboard bunker space, and this compressor is controlled by a combined pressure and speed regulator on the machine. The air, compressed to 20 pounds per square inch, passes through the oil heater above the oil bath and on to the burners direct, carrying with it any gases which may form over the oil bath, and thus preventing any dangerous accumulation of gas. An air receiver of about 30 cubic feet capacity is connected on a branch of this air line near the compressor, and serves the purpose of a pulsating chamber as well as an air-storage reservoir.

Precautions against flooding the furnaces, pumps, or hold with oil, in case of accident to the system, are provided for by check and relief valves fitted in proper places in the pipes. The four furnaces are each equipped with two oil burners, and the piping is so arranged that in case of accident to the compressor steam can be used to atomize the oil, instead of air, and the change can be made almost instantly. A small donkey boiler installed in the after fire room, equipped with grates for burning coal, is used to run the compressor and pumps when getting steam on the main boiler.

The system has proved very satisfactory in all respects, and thoroughly reliable and automatic in its action, the fireman regulating his fires simply with the lever on the burners, the supply of oil and air remaining uniform under all conditions, and no trouble has been experienced in producing steam to meet any demand or variation, and with absolute smokelessness.

NAME—Sea Rover. TYPE—Tugboat.
LAUNCHED—1902. NATIONALITY—American.
BUILDERS—Fulton Engineering and Shipbuilding Works.
OWNER—Ship Owners' and Merchants' Tug Boat Company.

Length over all	128 ft.	**Propeller,** number of blades	4
" between perps	120 "	Diameter	6 ft. 6 ins.
Beam, molded	24 ft. 4½ ins.	Pitch	15 " 6 "
Depth at side	15 ft.	Pitch ratio	2.04
Displacement at 11 ft. mean draft	410 tons	Developed area	40 sq. ft.
Block coef	.484	**Auxiliaries,** centrifugal pump	8 ins.
Area, midship section	191 sq. ft.	Centrifugal pump engine	6 x 6 ins.
Midship section coef	.755	Windlass	6 x 8 "
Bunker capacity	53,400 gals.	Capstan, steam	5 x 7 "
Engines, type	compound	Steam gear, double engine	4 x 5 "
Cylinder, diameter	17 and 21 ins.	Two feed pumps worked from crosshead.	
Stroke	28 "	Air pump worked from crosshead.	
Valves, piston or H.P., double-ported slide L.P.		Fire pump, duplex	10 x 6 x 10 ins.
Revolutions, per minute	110	Donkey pump...Admiralty.	7½ x 5 x 6 "
I. H. P.	750	Generating set	4 K.W.
Speed	12 knots	**Boilers**	one double-end Scotch
Condensing surf	13,20 sq. ft.	Pressure	175 lbs.
Diameter piston rod	4¼ ins.	Diameter	10 ft. 6 ins.
" crank pins	9 "	Length	16 " 6 "
Length " "	12 "	Tubes, 384	3-inch
" connecting rod	76 "	Furnaces, number of	4
Shafting, crank, thrust, propeller	9 "	Diameter, inside	36 ins.
		H. S. for oil burning	2,213 sq. ft.
		Compressed-air system	oil fuel

A Bad Collision.

During a very heavy fog in Boston Bay some time ago the steamship *Admiral Farragut,* of the Boston and Philadelphia Steamship Company, collided with the steamboat *Cumberland,* belonging to the Eastern Steamship Company. The resulting damage to the latter vessel is clearly shown in the accompanying engraving. The *Admiral* struck the *Cumberland* head on, forward of the paddle wheel, cutting through the guard and upper works, and crushing the side planking to the water line. Fortunately, however, the break did not extend very far below the water line, and the pumps were able to handle the water and keep the hold clear.

The *Farragut* suffered very little damage, the forward plates and stem being bent, but not pierced.

The *Cumberland* had undergone extensive overhauling last season, and, rather than place her again in dry-dock for the necessary repairs, the owners sold her.

THE DESIGN OF MOTOR LAUNCHES.

BY W. F. DURAND.

The problem of the design of a motor launch or other small boat naturally divides itself into two parts: the design of the form and the design of the structure. The form of the boat is chiefly responsible for the resistance to driving and hence for the speed with a given power, for the stability, the roominess or carrying capacity, and the safety in general, except as the latter may be dependent on strength. The construction of the boat relates simply to the realization in suitable building materials of the geometrical form decided on, so that the entire structure shall be strong, stiff and stanch, and adapted to the general purposes in view.

We shall in the present article consider briefly the question of the design of form and of the relation of form to the various items noted above. To this end we must first consider the various characteristics of form and their relation to the resultant form as a whole.

FORM.

Form presents itself under two aspects: the form of the under-water body of the boat, and the form of the boat as a whole. The form of the boat above water is, however, largely dependent on the form below the water line, so that the form as a whole is in large measure determined by the form of the under-water body. The qualities of the boat which are dependent on form are furthermore determined chiefly by the under-water body, so that for these reasons it will be sufficient for our present purpose to give our chief attention to the under-water form.

Form presents itself also under two other aspects, represented by *proportions* and by *fineness.*

PROPORTIONS.

By the proportions of the under-water body we refer to the general relation between the three chief dimensions, length or L, beam at water line or B, and draft which we may denote by H. These relations are usually represented by the ratios $L \div B$ and $B \div H$. The range in values of $L \div B$ is from 4.5 or 5 to about 10. Values near the lower limit are met with in wide and beamy boats intended for low or moderate speed, safety, and for ordinary knockabout purposes. Values near the upper limit are met with in long fine boats intended for speed and where considerations of roominess, stability, and weatherliness are not given so great weight. In general, with a given length, the greater the beam the greater the roominess, stiffness, stability, and general adaptation to knockabout uses, while the greater also the resistance and the slower the speed with a given power. On the other hand, the less the beam the less the resistance to propulsion and the higher the speed with given power, advantages gained, however, at the expense of accommodation space, stiffness, stability, and general safety. The relation between beam and draft, or $B \div H$, is naturally dependent on that of $L \div B$. A broad, beamy boat will, as a rule, be also relatively shallow draft, and, *vice versa,* a long, narrow boat will have a relatively smaller value of $B \div H$. The question of proportions is often determined by considerations relating to the service for which the boat is intended. Thus if specially shallow draft is required, the boat must of necessity be relatively broad in order to give the displacement needed to carry the weight of hull and machinery. On the other hand, if there are no limitations on draft the proportions may be made such as to accord with the general character of the design proposed. It must, however, be borne in mind that flat-bottomed, beamy, shallow draft boats and high speed are not consistent features and the latter must not be expected in a boat of this type.

At this point some reference may be made to the dimensions of the upper body as influencing the characteristics of the boat. In general and within suitable limits the higher the freeboard the better the seaworthiness of the boat and the wider the range of stability, while at the same time the greater the air resistance, especially in a head-wind. Thus, if speed is a primary consideration the boat should be low-lying and with the least surface to present to the wind. If, however, comfort, dryness, and general safety are of especial importance, then good freeboard should be provided, especially forward. It thus appears that so far as proportions go the typical knockabout safe "family carriage" boat will be of moderate draft, wide, and beamy, with good freeboard, especially about the bows.

In actual construction all types and proportions of boat are met with to suit varying ideas of designers or to meet varying combinations of requirements on the part of the owner. One thing, however, must be always remembered, and that is that the various good qualities, speed, roominess, stiffness, stability, general comfort, etc., cannot all be combined in maximum degree in any one design. Such considerations always demand a compromise, and it is simply a question of selecting such proportions of under-water body and of form as a whole as shall the best fulfill the requirements of the case in hand. The ordinary motor-boat from 18 to 25 feet long is usually given a ratio $L \div B$ of 5 to 6, higher ratios being met with in larger boats, until in case the length goes to 40 or 50 feet the ratio may rise to 8, or even 10 in extreme cases and where speed is the consideration of first importance.

FINENESS.

Turning now to the other aspect of form, that designated by the term *fineness,* we note that the term relates simply to the extent to which the block form, determined by the principal dimensions L, B, and H, is cut or fined away in various directions in order to give the actual boat form.

WATER LINES.

It will, however, be convenient first to explain the various plans and lines by means of which the form of a boat is represented on the drawing board. If we suppose the form cut by a series of planes horizontal or parallel to the water surface, they will cut from the surface of the boat a series of lines known as *water lines* and having the general form as shown in Fig. 1, *A*. Very commonly only the water lines on one side are shown, since the two sides are the same, and the plan showing such lines is, therefore, known as the *half-breadth plan.* If, again, we suppose the form cut by a series of planes vertical and transverse or perpendicular to the base line, they will cut from the surface

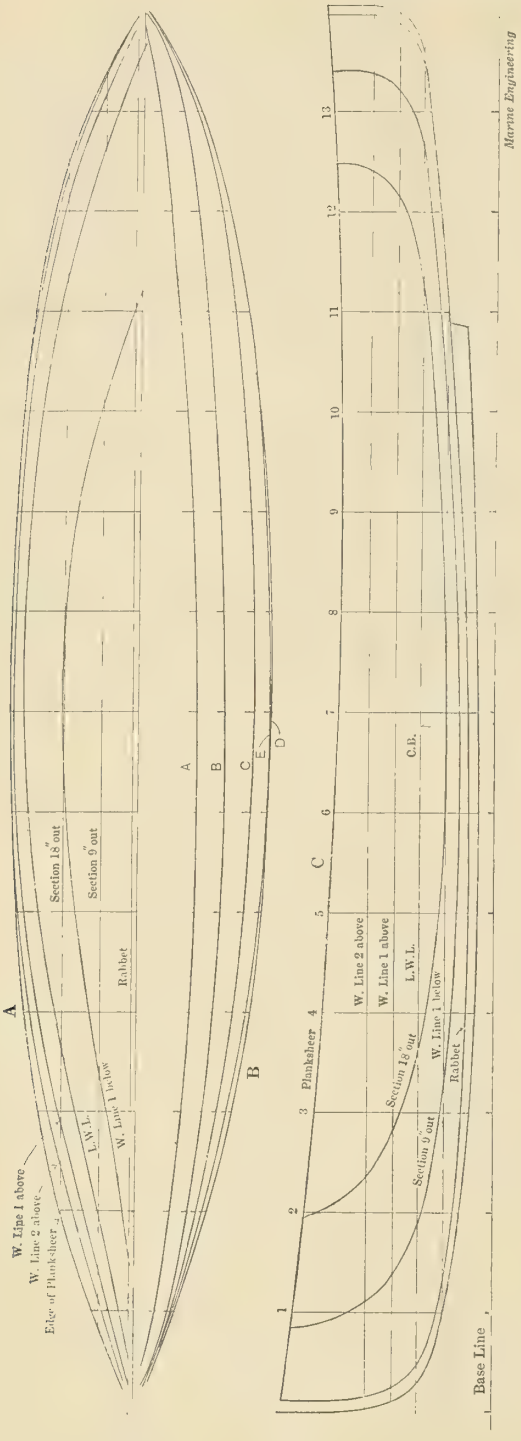


FIG. 1.

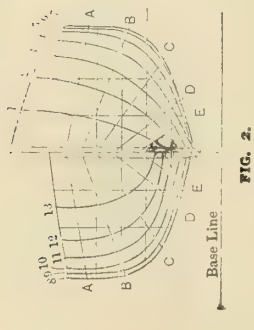


FIG. 2.

of the boat a series of lines known as *sections* and having the general form as shown in Fig. 2. Here again, since it is unnecessary to show the form on both sides of the boat, it is quite customary to show the sections for the after body on one side of the plan and for the fore body on the other, as in the figure. Such a drawing is known as the *body plan.* The plan shown in Fig. 1, *C,* and which gives the side elevation of the form, is known as the *sheer plan.* If the form of the boat were cut by a series of fore-and-aft vertical planes, the lines cut out of the surface would show in such a plan and are called *bow and buttock lines.* Two such lines are shown in the figure. Referring again to Fig. 2, if the form of the boat is cut by a series of oblique planes running fore and aft and lying, as nearly as may be, perpendicular to the surface at various depths, they will cut from the surface a series of lines which may be shown each in its own plane. Such lines, indicated by *A, B, C, D, E,* Fig. 2, are known as *diagonals* and are shown in true form in Fig. 1, *B.* Their chief use is in fairing up the other plans so as to insure a smooth and fair form, especially about the bow and stern. The number and location of such diagonal planes are left to the designer, having in view the characteristics of the case in hand.

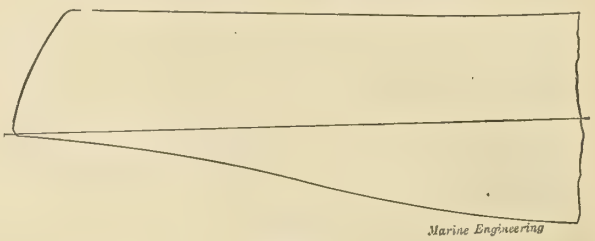


FIG. 4.

Referring now to Fig. 1, *A,* the water lines may be either fined away quickly fore and aft, beginning from the midship section, or they may carry nearly the full width for some little way amidships and then fall off sharply at the bow and stern, with, of course, all intermediate grades of fullness or fineness of water-line form. A water line may thus be said to be full or fine as the water-plane area is a larger or smaller fraction of the rectangle measured by the product of its length and breadth.

The form of water line for small launches will depend much on the character and service of boat desired. For comfortable, roomy boats with moderate speed the water lines will be full, showing a rather bluff bow and preferably a somewhat finer stern. As speed is more and more important, however, the water lines will be fined away, showing a long narrow entrance and fine after body or run. Regarding the after body, these remarks apply more especially to the ordinary or older type of stern, with stern post the full draft of the boat, and deadwood as indicated in Fig. 12. Within the past few years the so-called torpedo-boat or flat stern has, however, become a great favorite with many builders of launches and such craft, and its chief features may be here noted. In such form as shown in Figs. 1, 4, 5, 6 the after body is cut up, so that it comes to the surface at the stern, and the draft is nothing, or practically nothing, at this point. This fining

in a vertical direction allows, however, the water lines at the stern to be kept full and bluff or rounded, as shown in Figs. 1 and 7, thus presenting in this view, especially in Fig. 7, an entirely different appearance from that of the older form in Fig. 12. In comparing two such forms at the stern it must be remembered that the actual sectional area at any point is in each case about the same, and that in consequence the actual fullness or fineness may be substantially the same. In one case the depth of section is kept nearly constant and they are reduced or fined up horizontally, while in the other the breadth of section is kept greater with a correspondingly full water line, while the depth is de-

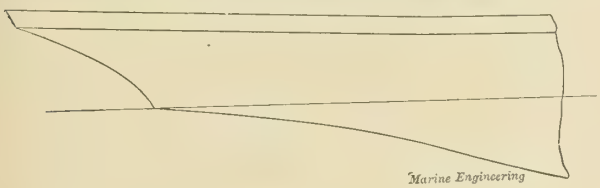


FIG. 5.

creased as the stern is approached, thus fining in a vertical direction instead of a horizontal.

BODY PLAN.

Referring again to the body plan, the sections may at one extreme be nearly rectangular, that is, with nearly flat bottom and straight vertical sides with a slightly rounded corner at the bilge, as in Fig. 8, *a*, or, at the other extreme, more nearly triangular with a sharp rise of floor or even hollowed in at the stern, as in Fig. 8, *b*, with, of course, all intermediate grades of sec-

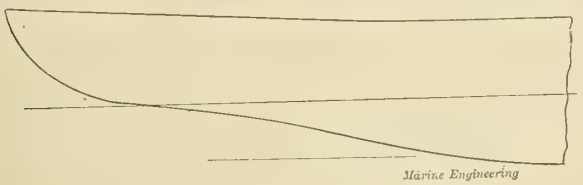


FIG. 6.

tional form, as in Fig. 1, *A*. The general character of the transverse sections is to a considerable extent dependent on that of the midship section, which thus serves as a general index to the form as determined by them. The usual form of midship section for motor boats shows a fair rise of floor on the bottom, with a well-rounded bilge and side somewhat sloping at the water line, rising to the vertical at the rail, as shown in Figs. 2 and 11. The form of section to be adopted in any given case is, however, largely determined by the special conditions of the case. Thus, if the boat is to be of the smallest possible draft, the midship section will necessarily have a rather flat floor and cannot be too much rounded off at the bilge; while, on the other hand, if the boat is high-powered, with propeller of relatively large diameter, and it is desired to have sufficient draft so that the keel will shield the propeller, a form must be selected which will tend toward the deeper drafts, and this will approach the so-called "peg top" section; that is, with a sharp rise of floor and rounded bilge. Again, it must be remembered that a flat, shallow section in a small boat is not the most favorable to seaworthiness, and that for general considerations of safety in a seaway the form of midship section should not too closely approach a shallow rectangle. Also for a given displacement the resistance is greater with a flat, shallow section with sharp bilges than with one relatively deeper and well-rounded on the bilge. For good speed, seaworthiness, and the best average combination of desirable qualities, therefore, the prevailing form of midship section in such boats is somewhat as indicated in Figs. 2 and 11, and for reasons as explained above.

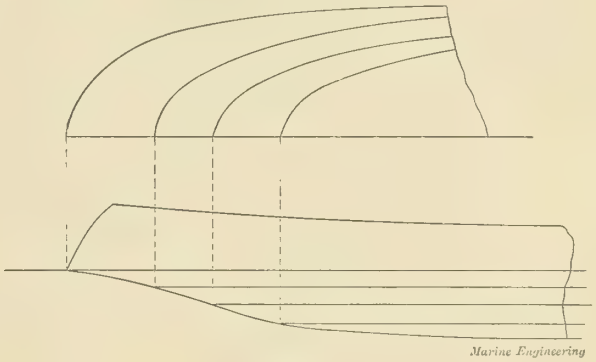


FIG. 7.

With the torpedo-boat stern the after sections become naturally shallow and relatively full. This, however, does not necessarily indicate fullness of form, as explained above. Regarding these two types of form at the stern, the chief advantages and disadvantages may be here noted.

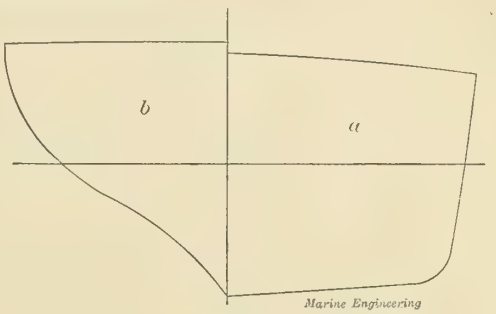


FIG. 8.

The torpedo-boat stern holds a full water line aft and thus tends toward greater roominess and comfort. The greater water-plane area is also favorable to stiffness and stability. Such form, especially with relatively large beam, is also more favorable to speed than the older form of stern. The water has a somewhat freer run to the propeller, the tendency of the boat to "squat" is less pronounced, and it is generally considered that, with a given power, better speed may be thus realized than with the older form of stern. On the other hand, such form of construction does not furnish protection to the propeller as with the older form, and it is also somewhat more difficult to give to the upper body at the stern such forms as we have been accustomed to consider graceful and pleasing. The structural features of such a form of stern may also present somewhat greater difficulties than the

older type. These various considerations must, therefore, be taken into account in selecting the form of stern, but, as indicated by recent practice, this form should be adopted whenever speed is an important consideration, and, perhaps, in the usual case unless protection to the propeller is a matter of unusual importance. In such case a thin skeg or even separate bar of steel is sometimes fitted to such a form of stern simply to furnish protection to the propeller.

COEFFICIENTS.

The general question of fineness is usually referred to a series of so-called fineness coefficients, of which the more important for our present purposes are three, as follows:

The *midship section coefficient* is the ratio of the area of midship section to that of the surrounding rectangle, or $B \times H$. Its indications show the extent to which the rectangle BH is pared or fined down in order to give the actual midship section.

The *block coefficient* is the ratio of the actual volume of under-water body to the surrounding block, $L \times B \times H$. Its indications show the extent to which the block LBH is cut away in order to give the actual form of the boat.

The *prismatic coefficient* is the ratio of the actual volume of under-water body to that of a solid the length of the ship, and with a constant section that of the midship section. The indications of this coefficient relate to the extent to which the sectional areas fore and aft are reduced in comparison with the midship section, or, in other words, it shows in a general way the distribution of volume fore and aft the length of the boat; or, still otherwise, it shows the relation between the average area of section and the area of midship section. Thus a prismatic coefficient of .65 would denote that the average area of section was .65 of the midship section, showing considerable fining down in one way or another, while a value .78 would show similarly a much smaller reduction of sectional area fore and aft, and a much fuller form as regards distribution of volume fore and aft.

DESIGNING FROM OLD LINES.

Having thus discussed in a general way the various features of form and their influence on the characteristics of the boat, we may approach the main question of the determination or design of a form in any given case. It should first be noted that but rarely is such a form designed absolutely new and without reference to previous forms. In any office where such work has been done in the past there may usually be found some form whose characteristics closely approach those of the form under consideration, and from such a form as a start the desired form may often be developed by relatively simple modifications. These modifications may be of two kinds: those involving a change in the proportions of length, beam, and draft, and those involving a change in the fineness coefficients, as discussed above.

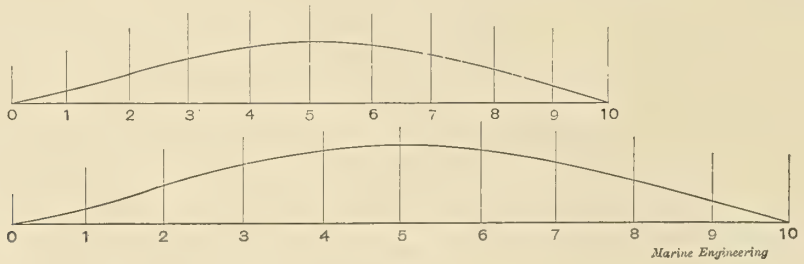


FIG. 9.

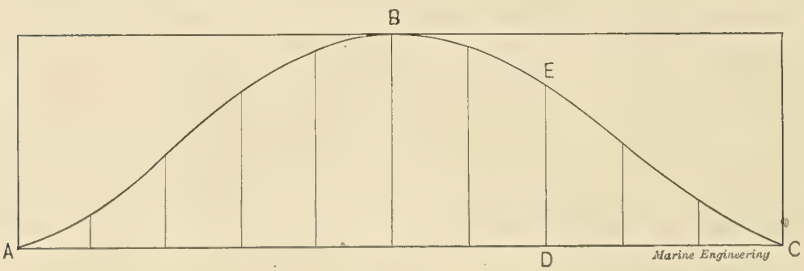


FIG. 10.

In the simplest possible case, if the proportions are suitable and the form characteristics satisfactory, it may be considered that no change in the lines is necessary, and that only changes in the actual dimensions will be required. In such case no new design is needed. All dimensions are increased or decreased in the same constant ratio and the determination is complete. In such case it is not, as a rule, necessary to make any change on the drawing board or to redraw the lines to a different scale. All such changes may be made in the general manner suggested below when the boat is actually laid down full size in the boat shed.

In the more common case the fineness coefficients and the form so far as determined by them may be acceptable, but it may be desired to change the various proportions of L, B, and H. Thus, suppose the original lines to relate to a boat 28 feet long, 5 feet beam, and 2 feet draft. It is desired to use the same general characteristics of form for a boat 33 feet long, 5 feet 6 inches beam, and 2 feet 6 inches draft. The various

proportions between the new and old would, therefore, be as follows:

Length ratio=33÷28=1.18. Beam ratio=56÷60=1.10. Draft ratio=30÷24=1.25. That is, the new boat will be 18 per cent. longer than the old, 10 per cent. wider, and with 25 per cent. deeper draft. Here again no work whatever need be done on the drawing board, as the changes required may all be made when laying the form down full size. A few hints regarding this operation may, however, be given. In order to obtain the form of section at each frame, spaced as may be desired, the water lines or half-breadth plan will be needed. To lay this down we note that the intervals between sections must be increased in the same ratio as the length. Thus, suppose in the original drawing that 10 intervals were used, giving a spacing of 2.8 feet fore and aft. The new spacing will be similarly 3.3 feet. The ordinates on each of these stations must then be scaled from the original drawings or taken from a table of offsets, and multiplied by the breadth ratio 1.1. This will give the lengths of ordinates to be

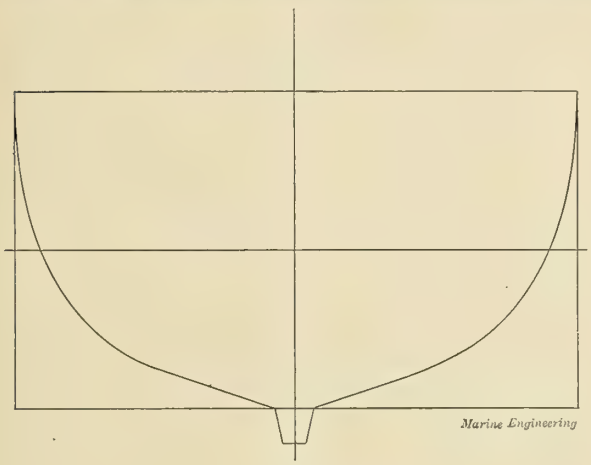


FIG. 11.

set off at the new stations, and the result will be the new water lines. This operation for a single water line is indicated in Fig. 9. In a similar manner the other water lines are run in, thus giving the half-breadth plan as desired. The new length of 33 feet may then be divided into any frame spacing as desired, and the locations of the frames drawn in. To lay down the body plan for these frames we then note that the vertical spacing of the ordinates must be increased in the ratio of the drafts, or 1.25. If, therefore, the old spacing was 3 inches the new must be $3\times1.25=3.75$ inches. Lines laid down to this spacing may then be laid off and the ordinates taken from the new half-breadth plan will give correctly the forms of the sections or frames.

In carrying out such operations, and after the lines themselves have been determined, it may be desired, as a matter of record, to lay down a new set of water lines in the body plan, spaced at some even interval, as 3 inches, in order to make the ordinates of the present form a matter of record in a table of offsets. In such case the additional lines may be preferably run in with a different color in order to avoid confusion between the two sets of lines.

There are, of course, many practical details of the operation which we cannot refer to in the present brief account, but in the general manner indicated it will be possible to lay down a new set of lines from an old, and having the same coefficients of form, but with proportions of *L*, *B*, and *H* changed as may be desired. It may often happen that two or even all three of the ratios above referred to are the same, as, for instance, in a case where we wish to retain in the new boat the same ratio of beam to draft as in the old, or, as may happen, where the proportions throughout are the same, the size alone being changed, as in the case first mentioned above. In case the new dimensions are smaller than the old or some of them smaller and some of them larger, the same general method will apply; and in all such cases where the form coefficients are to be left unchanged and the proportions alone modified, this general procedure will serve to determine all features of the new form as may be desired.

In many cases, however, it will be desired to modify the form coefficients as well; that is, to change the character of the midship section, to fill in here or fine away there, and so in various ways to modify the characteristics of the original form. In such case the problem should be taken up on the drawing board and the new form determined to a first fairing before proceeding to lay it down full size on the floor. The extent of such modification may be determined by three considerations: the satisfaction of the eye as a judge of form or proportion; the satisfaction of the judgment regarding suitable or desired values of the form coefficients; or the provision of some needed dimension or space for reasons of structure or arrangement.

If the extent of such changes is not great the original lines, especially the body plan, may be taken as a foundation, and the changes lightly sketched in free-hand, fining or filling in and changing until from one consideration or another the desired form is approximately determined. If these changes have been carried out on the body plan the result on the fairness of form must next be determined by reference to water lines, bow and buttock lines, or diagonals. It will thus be found that, in order to run in smooth lines on the second plan, slight changes must be made in the sections of the body plan, still retaining, of course, their own fairness and smoothness of form. In this way it will be necessary to make slight changes back and forth between the two sets of plans, say the body plan and water lines, until finally both are as nearly fair as may be determined on the reduced scale used on the drawing board. As a final test a few diagonals or bow and buttock lines may then be taken, and, if fair, the entire form may be considered ready for transfer to the floor. In making any such series of changes it must, of course, be remembered that changing any one section, for instance, will necessitate a change in all the water lines in the neighborhood, and hence, in order to retain the latter fair, a change in all the sections for some little way fore and aft. This operation of changing back and forth between two or more sets of lines, or fairing, as it is termed, involves many minor points of detail which cannot be here considered, but which will appear in the actual case, and regarding which experience is the best teacher. The final

purpose is, of course, the determination of a smooth and fair form with the general proportions and characteristics considered desirable in the case in hand, and if a form nearly fulfilling the desired conditions can be found as a start, the method above outlined will serve to develop the desired changes.

CURVE OF SECTIONS.

The characteristics of the under-water body are often judged in large measure by the so-called curve of sections or curve of sectional areas. This is a curve as illustrated in Fig. 10 and laid off on the length of the boat, and such that any ordinate, as *DE*, represents the area of section up to the load line at that point in the length. It may be shown that this curve with boats having the older form of stern represents in its general form, as regards fullness, the average water line, and also that its own fullness coefficient, or area divided by length times greatest height, is exactly equal to the prismatic coefficient as defined above. This curve shows in fact just how the volume of the under-water body is distributed fore and aft, and is of great importance from the standpoint of resistance and propulsion. To lay down such a curve in any case, having given the body plan, it is simply necessary to

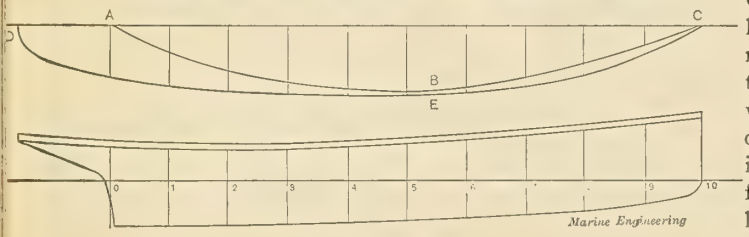


FIG. 12.

find the area of each section by itself and then to plot them to any convenient scale in the manner shown in the figure. To find the areas a planimeter is most convenient, though of course they may be found numerically by the use of Simpson's or other similar rules for the areas of irregular figures. In the case just referred to, of changing by fining or filling in, either in fore body or after body or both, the smoothness with which such change in the distribution of volume is effected may be judged by the curve of sections, and, as a rule, it may be recommended to compare the old and the new curves as a further test of the features of the new form.

LAYING DOWN A NEW DESIGN.

We have thus far considered the design of form, starting with an existing form as a basis, and requiring only relatively slight modifications to fulfill the conditions of the case in hand. In the more general case, when no such form is available, the entire design must be new from the start and the chief steps in such an operation may now engage our attention. It is clear that such a form cannot be developed without something to start with. It cannot be evolved out of the air, so to speak, and one must have certain conditions or characteristics from which to begin the solution of the problem. These fundamental data must be either furnished us by the conditions of the problem or must be assumed to an extent sufficient to make the solution practicable. The features to be thus chosen or assumed will vary somewhat with the taste or choice of the designer. Here as elsewhere there is no one way along which we must travel. Many routes lead to the same goal, and it becomes a matter to some extent of individual choice. For most cases the following may be suggested as a safe and satisfactory routine.

The length, beam, depth, and draft are supposed to be given. The next step may be to lay out the form of midship section, or if the given beam is that at the water line the beam and draft give the rectangle surrounding the immersed part of the section. In either case the form of the entire section must be sketched in, having in view the general influence of this feature on the design as a whole, as previously discussed, and selecting such a form as may seem best adapted to the purposes in view. This step is indicated by Fig. 11.

Having selected the form of midship section, the next step may be to run in a sheer line and keel as in Fig. 12, thus fixing the general contour of the boat as seen in side elevation. At this stage the form of stern must be selected, whether torpedo-boat or with deadwood, and the keel line then adjusted accordingly. One of the great difficulties with the torpedo-boat stern has been the adjustment of the upper body in such manner as to suit our ideas of comeliness. The full typical form is shown in Fig. 4, and, while often met with in pleasure boats, does not always meet the views of the purchaser. Other forms of treatment are shown in Figs. 1, 5, 6, with varying degrees of roundness or fullness for the horizontal sections above the water line. The next step may be to run in a load-water line, *A, B, C*, Fig. 12; a rail line, *D, E, C;* and a curve of sectional areas, *A, B, C*, Fig. 10. These three lines cannot be selected independently, but must be determined with reference to each other. If the form has the older stern, as in Fig. 12, the curve of sections, as we have seen, represents nearly a mean or average water line, so that in relative fineness the curve of sections will be fined away the most, the load-water line next, while the rail line will be much fuller, according to the room required and the desired form for the upper body of the boat. The load-water line and rail line must agree at the midship section with the form decided upon for this section, as in Fig. 11; but aside from these two points and the ends, the lines are undetermined and must be taken according to the best judgment available. It is probable that the three lines thus selected will not satisfactorily agree; that the curve of sections will prove to be too full or too fine for the load-water line or that the latter is not of form suitable for the curve of sections as taken. All this, however, can only be ascertained by the further development of the form. To this end we may take any section, as No. 7, and note its area as measured from the curve of sectional areas. Divide half this area by the product of the half breadth of the section, as shown by the water line at No. 7, multiplied by the depth as taken from the sheer plan. This will give the fineness coefficient for this section. It will show to what extent the rectangle *A, B, C, D*, Fig. 13, must be cut away to give the half section *A, E, C, B* with area as required. A little experience will enable one to

make a close estimate of the shape, knowing the coefficient to be realized. Thus, if the area of No. 7 is to be 70 per cent. of the area of the rectangle, it shows that *A, E, C, B* must be 70 per cent., or a little less than three-quarters, of *A, B, C, D,* and a little experience will make it possible to sketch in a section nearly fulfilling these conditions. A few trials checked by a planimeter will serve to quickly bring the area to the value desired within a satisfactory limit of accuracy. In thus sketching in the section reference must be made to the point *F,* determined by the rail line, so that the entire line *A, E, C, F* may be run in smoothly and fair and with the general character of section desired. In the same manner the other sections may be run in, care being taken to give to each the general characteristics of that next to it, so that the transition in form from the midship section may be gradual and smooth. For this reason it will be well to start from the midship section and work each way, running in No. 6, for instance, quite similar in form to No. 5, the midship sec-

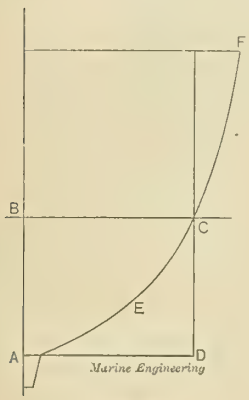


FIG. 13.

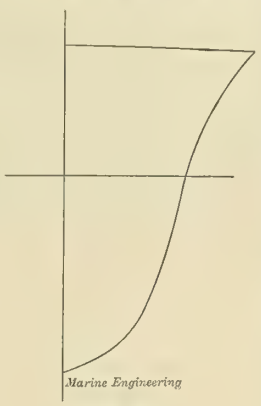


FIG. 14.

tion, and only reducing it as may be required to suit the decreased width at water line and decreased area as shown by the curve of sections. Next No. 7 is determined, with only a moderate departure in general form from No. 6, but with probably a growing departure from No. 5, and so on to the bow. In the same general manner the after body is determined, both under water and above. In case at any section the various lines assumed do not agree in such way as to make the form practicable, the fact will be shown by an excessively large or small section coefficient at this point. Thus it would be quite possible to assume a curve of sections and a load-water plane so related as to require a given section to be almost or quite rectangular at one extreme, or triangular, or even finer, at the other. In such a case the form of these curves must be so modified as to give sections throughout having the general character of form desired. In some cases it is desired to keep the rail line forward especially full for roominess. This may be done by introducing a reverse curve in the sections above the load-water line, as shown in Fig. 14. In this way, without increase of under-water body and with relatively fine under-water lines, the upper body may be made full and roomy.

When the sections have thus been sketched in the result will be a series of lines fulfilling closely the conditions assumed as regards distribution of area fore and aft, load-water line and rail line. It is practically sure, however, that a boat built to such lines would not show a fair continuous surface, but would develop humps and hollows, flat spots and irregularities, surprising to one not accustomed to such matters. If, therefore, in a general way the conditions specified are fulfilled, the next step must be to insure the fairness and continuity of the form. Space forbids any detailed description of the operations involved in thus fairing the first crude results. In general the first step will be to run in a further series of water lines, preferably, perhaps, one at mid-draft next. The probabilities are that this will be found unfair and will show needed modifications in the sections. The same general operations are carried out here as referred to at an earlier point in connection with fairing up after slightly changing a given form. The mid-draft water line will show needed changes in the sections, and these will require further changes in the water lines, and so it is often necessary to work back and forth, gradually approaching a condition where both sets of lines shall be fair. In the same way other water lines may be run in and faired one-half way as nearly as may be between the rail line and load draft, and then others, until the two series of lines are as nearly fair as may be readily effected with the reduced scale used on the drawing board. In fairing the lower part of the under-water body, and especially about the bow and stern, much help may be derived from bow and buttock lines or from diagonals, as previously discussed. One advantage of diagonals is that they often lie approximately in the line of the strakes of planking and hence show just how such strakes will be bent and furnish a test of fairness in this direction. Often the bow and buttock or diagonal lines will serve to show small residual irregularities of form or undesirable features, such as relatively flat or concave spots, which might have been overlooked if tested only by sections and water lines.

One thing must be clearly understood, and that is that there is no royal road to the fairing up of a ship's form when developed in this way. It requires care and patience and often a long series of transfers and changes back and forth before all sets of lines are fair and "sweet" and the conditions imposed are all fulfilled.

The method of developing a design outlined above is adapted especially to cases in which the qualities to be obtained may be satisfactorily expressed in terms of the form coefficients and the general characteristics of a curve of sections. In cases where the judgment is uncertain on some of these points, or where the designer may prefer to determine the form more directly, the same ultimate end may be reached by selecting first a midship section, as before, and then with the pencil sketching in lightly the various half sections of the fore body on one side and of the after body on the other. Aid may be obtained by looking at a body plan with features somewhat similar to those desired, and distributing the sections in a generally similar manner. By carefully noting the relation of one section to the next and working from the midship section each way, a form may be developed which will not be very far from fair, and which will possess the general features desired, so

far as such may be determined by reference to the sections. The fairness and continuity, both of surface and volume, must then be determined by running in from the sections thus laid down a set of water lines or diagonals and a curve of sectional areas. These will, doubtless, reveal irregularities in the surface form and in the distribution of volume. With such indications in hand, the sections may then be modified and faired up with the water lines or diagonals, and the resulting form coefficients and curve of sections noted, until, in this way, the various plans shall be made fair and the general features shall be considered satisfactory for the case in hand.

The first method, in substance, involves the fixing of certain conditions or features, as expressed by the form coefficients and curve of sections which the form is to fulfill, and then determining a form which shall fulfill these conditions as nearly as may be finally decided desirable. The second method, in substance, involves the determination of a form direct without other guide than the eye, and then the testing of this form by reference to the form coefficients and curve of sections, until again the result shall be considered satisfactory for the case in hand.

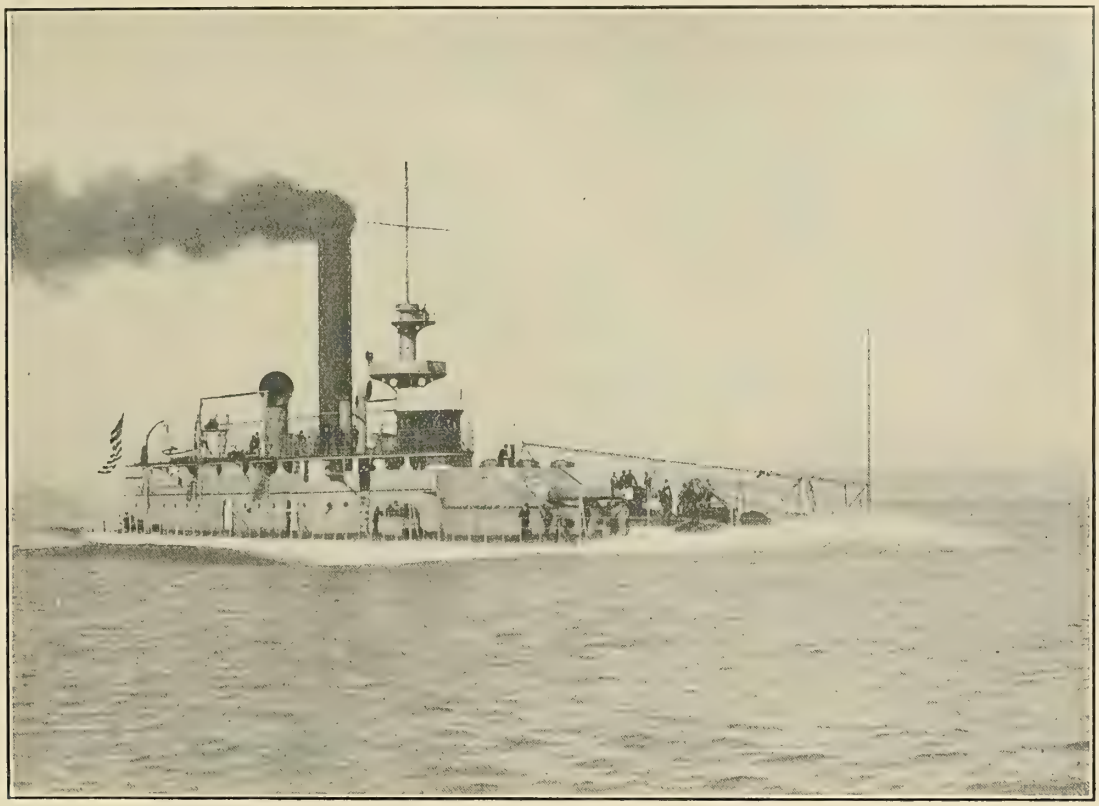
Still otherwise, especially in earlier years, the forms of boats were commonly determined by direct reference to a model formed in wood and to such reduced scale as convenient. This method has the advantage that it allows of eye judgment of the solid form, and this is more satisfactory than by judgment "in the flat," as on a drawing board. It has the disadvantage that the form must be developed wholly by eye judgment, and that in case, in the modifications here and there, it should be made too fine, the correction is not easy. It is often desired to note the result, for example, of fining here and there. This may be readily done on paper, lines may be run in and rubbed out, and the form may be modified as often and as much as may be desired, without prejudice to the final completion of the problem, with the same general layout as at the start. With a wood model, however, it is, of course, impossible to take off and then put on, and great care must be exercised when approaching the final condition, lest too much be removed and a spot undesirably lean be produced.

After the wood model has been brought to what seems to be a satisfactory form, the various sections and water lines should then be located and the ordinates determined by calipering, or by such other method of measuring as may be convenient. From these measurements the form coefficients should be determined and the curve of sections laid down, so that the result may be judged in the light of these items. The result may indicate a satisfactory combination, or it may show that further change is needed, especially as regards the relation between draft, displacement, and carrying capacity.

On the other hand, when the form is determined on the drawing board, especially if it contains features of novelty, it may be recommended to make a model representing such form before laying it down full size and proceeding with the construction. This is the inverse of determining the lines from the model. The operation of cutting a model to represent a set of lines involves many details, and we can only note briefly that it may be done in two general ways. (1) A solid block may be glued up and then pared down, as tested by molds cut out to fit around the form of the sections, until, at a series of stations, the block is reduced to the desired form. The intermediate parts are then brought down and the whole faired up. (2) A series of "lifts," or boards of thickness to represent the space between the water lines, is prepared and the water lines laid out one on each. The lifts are then cut out, each to its own water-line form, and these are then pegged together or glued up, as may be desired. The corners are then brought down so that the form is smooth and continuous and with water lines as laid out. Very often, from the indications of such a model carefully made, it will be found desirable to slightly change the form one way or another, and this may be done on the drawing board and followed up on the model, until, between the two, the result fulfills the judgment taken from all possible points of view.

At this point it may be asked, What assurance have we that when built the boat will come to the draft designed? In reply we can only say that in the absence of actual information as to the weight of the boat and machinery, or elaborate calculations relating to the same, we may depend upon it that if of ordinary proportions and construction, and if powered within reason, there will be left over a certain margin before bringing the boat down to her designed draft. This margin may be utilized for passengers, etc., and if the boat is of any but the smallest size there will be sufficient range to provide for all ordinary requirements with a boat of this character. There is no requirement, of course, that the boat should always or necessarily run at just the designed draft. In small boats there is often much variation according to the load carried, and so long as the freeboard remains sufficient for safety the fundamental purpose of the boat may be satisfactorily fulfilled. With accurate knowledge of the weights of boat and machinery or with a sufficiently careful and extended computation, the amount of carrying capacity at any water line may, of course, be accurately found by subtracting the total weight of boat, machinery, and equipment from the total displacement as given by the immersed volume up to the water line in question. In the usual case, however, there will be some uncertainty regarding the schedule of weight, and the best estimate must, therefore, be made which the data available will permit.

In this brief discussion of some of the points which will enter into the considerations of the design of the form of a small launch or motor boat, many details have been omitted, or only briefly referred to. The purpose has been to aid those who already have some acquaintance with such matters to use their judgment and experience to the best advantage, and to give such hints as may enable those quite unfamiliar with the matter to undertake the study of the problem of design in the way likely to be most instructive to them, and in which they will be the best able to learn for themselves, and thus to develop such skill as they may have for this class of creative work.



UNITED STATES MONITOR WYOMING ON TRIAL IN SAN FRANCISCO BAY.

Monitor Wyoming.

The latest addition to the heavy ships of our navy on the Pacific coast took place with the acceptance of the monitor *Wyoming*, built by the Union Iron Works, of San Francisco, Cal. The keel was laid on April 11, 1899, and the vessel launched on September 8, 1900. The *Wyoming* was recently run on several preliminary trial trips in San Francisco bay, upon which the required speed was exceeded. In November the final trial was run at sea outside of Golden Gate, and a speed of 12 knots was maintained.

The *Wyoming* is one of four monitors authorized by act of Congress, May 4, 1898, and is of the following dimensions:

Length on water line	252	ft.
Extreme beam	50	"
Depth, molded	14 "	10 1-2 in.
Draft, mean	12 "	6 "
Displacement	3,214	tons.
I.H.P.	2,400	

The machinery consists of two sets of vertical triple-expansion engines, 17, 26 1-4, and 40 inches being the cylinder diameters, and the stroke 24 inches, indicating about 2,400 H.P. Four Babcock and Wilcox boilers are installed, having 216 square feet grate surface.

In point of armor, the low freeboard is protected by armor 11 inches thick, tapered to 5 inches at the ends. The forward turret armor is 10 inches thick and protects the main battery, consisting of two 12-inch breech-loading guns. The turret is mounted in a barbette. In the superstructure are mounted four 4-inch R.F.G., three 6-pounders, five 1-pounders, and two Colts.

Oil-Tank Vessels.

BY D. CURRIER.

The carrying of crude petroleum in bulk, and the experiments of adopting oil for fuel in place of coal, will in a great measure change the general construction of ships for the oil trade, both in building and repairs. A number of Lake boats have been brought to our Atlantic coast repair yards, where they are being reconstructed, and several oil companies have given out contracts for the building of oil-carrying barges and steamships.

Of those rebuilding at the repair yards, the style of work and the necessary changes thereby, the following is a brief synopsis.

The decks are generally overhauled, and all butt laps, landings, and riveting are increased to insure oil-tight work. In many places, where the old spacing of rivets is 7 to 8 diameters, the old rivets are left in place and new ones are equally spaced between. In connections where there is now oil-tight work, the rivet spacing runs about 4 diameters, except in the frames and beams, where it is as high as 7 and 8 diameters; but in landings, which are usually double-riveted, and in treble and quadruple butts, the oil-tight spacing of rivets required is 3 to 3 1-4 diameters. In angle iron, where the size of the bar permits, staggered riveting is used.

Looking to its future efficiency, the decks have additional beams of angle steel, 6 by 3 1-2 by 3 1-2 by 1-2 inch, fitted between the present ones and connected to the frames and center-line bulkhead by 18 by 1-2-inch brackets. Half beams, bracketed in a similar manner, are fitted in way of the hatchways.

These vessels generally have 8 by 3 1-2 by 3 1-2 by 1-2-inch channel frames, and to insure oil-tightness at the decks, and to further stiffen the same, the frames are cut just below the main-deck stringer plate and at a height of 6 inches above the stringer plate. The stringer angle on top and the intercostal bar underneath are removed, and a flanged plate is substituted on top, about 18 inches wide, 5-8 inch thick, and extending about five frame spaces, riveted to the stringer plate and connected to the shell by a double row of 7-8-inch countersunk rivets about 3 1-2 diameters center to center. This flange plate is well calked. Where these frames have been cut above the flanged plate, brackets 24 by 1-2 inch are fitted, riveted to the frames with 7-8-inch rivets, and connected to stringer plate, clearing the flanged plate, by double clips, with about four rivets in each flange.

The ship is divided into eight oil-tight compartments, into which the crude petroleum is pumped in bulk. The divisions are: five transverse bulkheads of 7-16-inch plating, and a continuous center-line bulkhead with the same weight of plating. These bulkheads are stiffened by 6 by 4 by 1-2-inch angle bars, spaced about 24 inches apart. In one case a 6 by 3 1-2 by 3 1-2 by 1-2-inch Z bar was used. All the bounding angles are 5 by 5 1-2-inch angles, with staggered double rivets in each flange and all countersunk. Snap riveting is not generally used.

At certain distances apart, web plates, bounded at each edge, top and bottom, by 3 1-2 by 3 1-2-inch angle bars, are put in for the extra stiffness, both horizontal and transverse. The center-line bulkhead is stiffened in a similar manner.

Because of the old riveting in the vertical keel angle-iron bars connecting tank top to keel, the center-line bulkhead is moved 5 inches off the center line of the ship, and to further promote equal balancing the bulkhead center line in each oil-tight compartment is alternately placed, first on the starboard side, then on the port side, and so on, keeping 5 inches off the center line to avoid the old riveting. Where the old bulkheads are used, they are all stiffened and strengthened by vertical and horizontal stiffeners, and the new 5 by 5-inch bounding angle is substituted for the old and smaller one. All the plating on these bulkheads, both transverse and center line, is laid vertically, the plates averaging about 5 feet in width, in several places 7 feet, and extending from tank top to upper deck.

From main to upper deck expansion trunks are fitted, which utilize the old hatch spaces, extend to about 6 feet above the upper deck, and are about 14 by 36 feet. They are subdivided by the transverse bulkheads and are plated over on top. Hatches are fitted between the expansion-trunk beams, and water- and oil-tight covers are battened down over the hatches.

Just aft of the hatchways forward and on the main deck is the pump room, in which two sets of double-acting pumps, Worthington, Dean, or the like, are placed. From these pumps run the suction and discharge pipes to each oil compartment. These pipes are so arranged that one set of pumps draws from two compartments, the second set from two more, and when necessary both can be brought to bear on one compartment. Forward of the oil compartments is the cargo space.

In meeting the new work with the old, where possible the old work is not touched. The riveting, perhaps, is one of the most important factors, and great care must be taken. All seams are double-riveted, with close spacing of rivets, running about 3 diameters. In some places there are treble-riveted butts, but generally they are double-riveted like the landings. Outside of the complete overhauling and the placing of new work, the positions of compartments on decks are not changed, unless, perhaps, the removal of coal houses and the like. The machinery and boiler space remains unchanged.

The oil is pumped into the compartments until it reaches a level about 2 feet above the upper deck in the expansion trunk.

It will be interesting, certainly, to watch the tests of these vessels as oil carriers and determine whether it is cheaper to renovate the old vessels or build new ones for the oil trade, so rapidly coming into prominence and destined, perhaps, to increase many fold.

Oil Fuel on the Pacific Coast.

The use of oil fuel is the all-absorbing topic along this coast at present. The indications seem to be that before long a coal-burning steamer will be a curiosity.

Prior to January 1, 1902, the only marine oil-burning installations to be found here were on the local ferry-boats, on a few steam coasting schooners, and local harbor craft.

Starting with S.S. *Enterprise,* of the Matson Navigation Company, which went into commission as an oil burner a few months ago, there has been a steady increase in the use of this system for deep-sea steamers. The *Enterprise* plies between San Francisco and the Hawaiian Islands. Her first trip from this port was looked upon as more of an experiment, and many people argued that she would never get back, unless she came under sail. Her success, however, has been well assured in the subsequent trips. A detailed account of this matter was given in MARINE ENGINEERING for September.

Probably the best evidence of the success of this steamer is shown by the fact that the Matson Navigation Company is now fitting up another steamer in the same manner. This company recently purchased the United States Army transport *Rosecrans* and is now having her overhauled at the Union Iron Works for conversion into an oil-carrying, oil-burning vessel. She will have a capacity for 22,000 barrels of oil in bulk and will run to the Hawaiian Islands.

Following the *Enterprise,* the next steamer to leave port with oil fuel was the *Mariposa,* a description of which was given in Admiral Melville's report printed in the December number. This vessel has proved to be the most successful of any of the new installations so far. The owner, the Ocean Steamship Company, has ordered her sister ship, the *Alameda,* to be taken off the line and converted into an oil burner. The American-Hawaiian Company has the two newest and largest steamers burning oil—namely, the *Nevadan* and *Nebraskan.* These ships came round the Horn to engage in the Pacific coast-Hawaiian trade. They burned coal

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on this trip, but immediately on arrival were converted into oil burners, all the necessary apparatus having been brought out from the East. In this system oil is atomized by air at a low pressure—in the neighborhood of eight ounces. On the *Enterprise* steam is used for atomizing, and on the *Mariposa* compressed air at 20 pounds per square inch is used for this purpose. At present the results from only the *Mariposa* are given out.

Much valuable time is saved in supplying a vessel with oil fuel over the time taken to coal a ship. The *Nevadan* gave an object lesson in this respect after her arrival at San Francisco. On her way from New York to this port she burned coal, and at Coronel, South America, she coaled for San Francisco. It took two whole days to fill her bunkers. When she filled up with oil here 4,500 barrels were transferred into the tanks in five hours, and the operation involved no soiling of decks or any hard labor on the part of her crew. Forty-three hours were thus saved in the time of taking oil fuel aboard, as compared with the time consumed in coaling for a voyage of corresponding length. Time is as much of an item to be saved as anything else. Oil can be handled without the employment of manual labor, transferred to the tanks aboard ship, and from them to the furnaces by its own gravity.

The growing use of oil on this coast has caused many steamers formerly engaged as colliers to break into the general carrying trade, and this has worked to the great disadvantage of sailing vessels. Most of these ships now bound here from Australian ports, which would, under former conditions, have been laden with coal, are coming in ballast. Regardless of this fact, additional tonnage is coming to this coast to engage in regular trade between here and the Orient. This seems strange, in view of the number of United States Army transports now laid up at this port and offered for sale. The recent order of the Army Department to send but one ship per month to the Philippines caused the transports to block up here, until no less than eight (a good-sized fleet) were lying idle in San Francisco harbor. Many of these were offered for sale, but could bring no satisfactory figures, and so were retained by the Government.

Annual Report of Rear Admiral Bradford.—Admiral Bradford, Chief of the Bureau of Equipment, in his annual report to the Secretary of the Navy, again protests against the action of the Department in substituting a naval constructor for a line officer in shipbuilding works. In the construction of steamship vessels the work is generally supervised by an experienced master mariner and chief engineer, and the admiral believes it is essential that the equipment of a warship should also be under the supervision of men with an extended working experience. The total amount of coal purchased during the year was 382,040 tons, at an average cost of $5.81 per ton, against $7.01 last year. The amount used for steaming purposes has increased more than five times during the past ten years, but the amount of domestic coal purchased has increased 34 per cent. and the foreign coal bought decreased 16 per cent. The admiral recommends, as in his previous report, the building of two large steam colliers capable of carrying 10,000 tons of coal as cargo and 1,000 tons in bunkers.

ATLANTIC TRANSPORT STEAMERS MISSOURI AND MAINE.

Among the most interesting vessels under construction in America to-day are the *Missouri* and *Maine*, building at the Maryland Steel Company's yard, Sparrow's Point, Md., for the Atlantic Transport Company.

These vessels, although of the same length as the *Manhattan* and *Michigan*, built by Messrs. Harland and Wolff, are quite different in all other respects, the hulls being under the "three-deck rules," and thereby stronger. They have also two feet more beam, more commodious quarters, and more power, together with increased speed. The general dimensions are given in the table at the end.

The hulls are constructed of mild steel throughout, built under Lloyds' rules for the highest class. The classification of the American Bureau has also been obtained. The frames are of channel bars, spaced 30 inches center to center amidships and aft, reduced to 26 inches at forward end. Provision has also been made for the great stresses occasioned in full-modeled steamers when running light, by doubling the frames and by thickening the shell plating and treble riveting the laps of same. There are four steel decks, extending all fore and aft, with channel beams fitted on every frame. The upper deck forward and aft in the crew spaces, and the shelter deck above these spaces, are wood-sheathed.

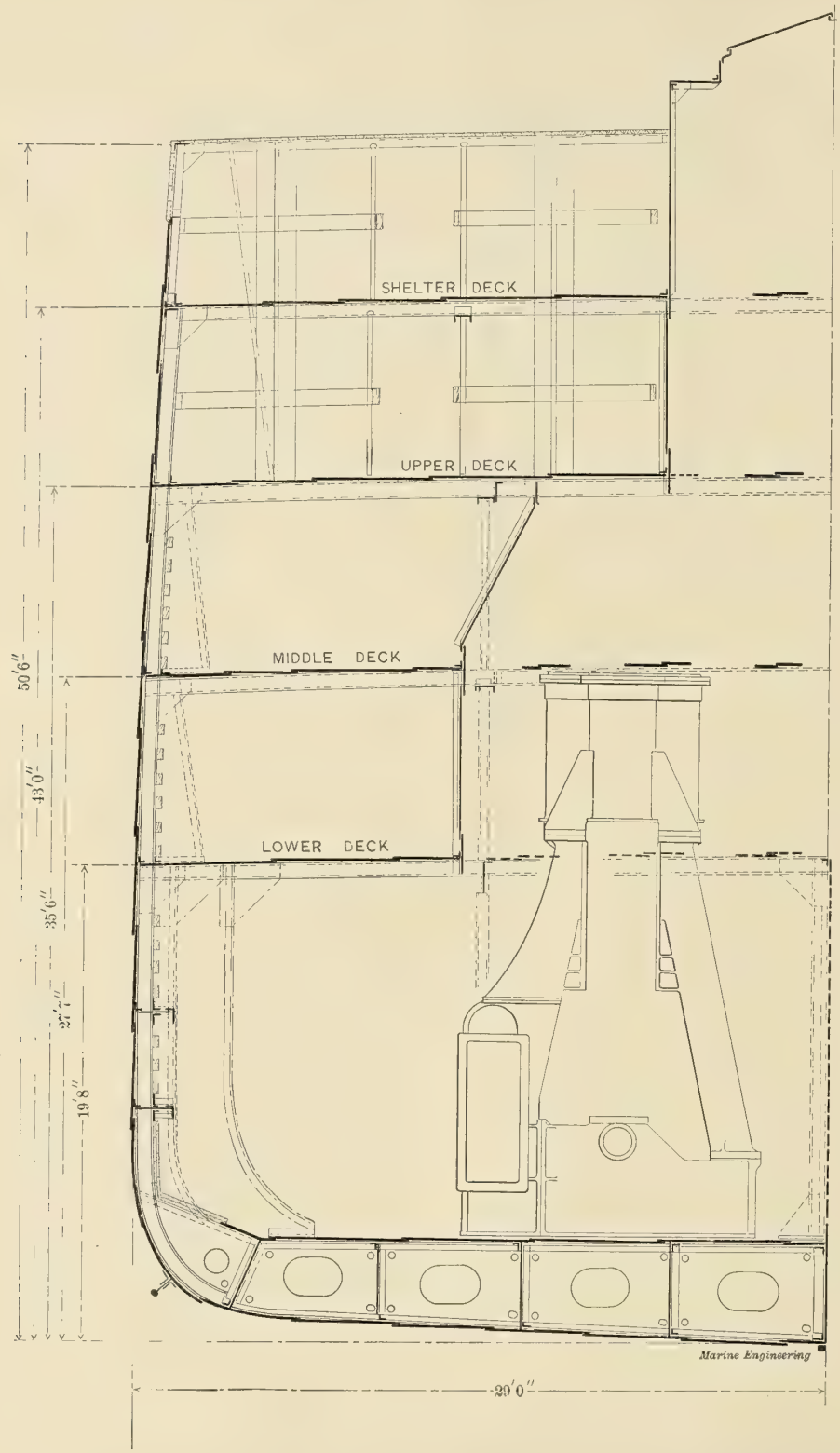
Eight water-tight bulkheads extend to upper deck. In addition to this, there are three bulkheads extending to middle deck to form coal bunkers, and one to middle deck to form deep tank. The peak bulkheads extend to shelter deck. The bulkheads are stiffened by a method designed by the Maryland Steel Company, securing a maximum amount of strength with a minimum of material. This arrangement also facilitates the loading and discharging of grain, which is generally carried in these compartments.

The water bottom, constructed on the cellular system, extends from the forward collision bulkhead to a partial bulkhead on frame No. 22 aft. There are solid floors fitted on every frame, with three intercostals on each side of center line. These intercostals are carried well forward and aft, stiffening the flat portions where pounding is likely to occur. Aft of the water bottom a water-tight flat on the line of second hold stringer forms the shaft alley recess, being divided at center line by a water-tight bulkhead provided with a door to facilitate repairs. The capacity of water bottom is 1,524 tons. In addition to this there are 189 tons of ballast in the peak tanks, and 2,005 tons in the deep tanks forward and aft.

The lower part of the stem, the stern post, and the hangers are of cast steel, and the rudder is forged and of the single-plate type. The hangers are made of two castings, bolted at the center line, being entirely independent of the stern post.

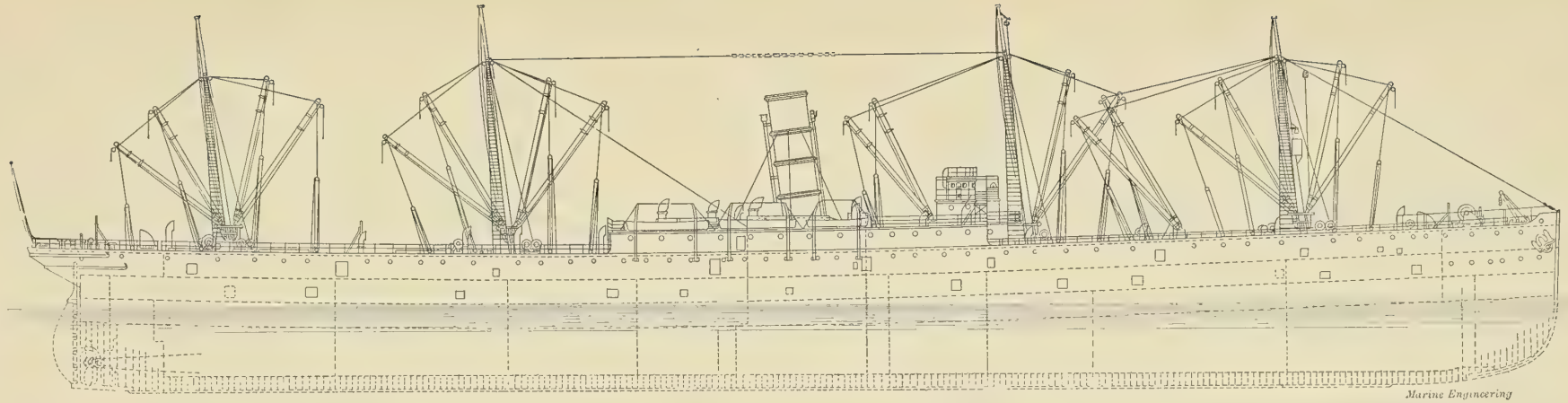
Nine hatches extend through all decks; those in deep tanks being divided by center-line bulkhead and fitted with water-tight steel covers. No. 7 hatch, on shelter deck, is arranged as a tonnage opening. All other hatches are fitted with wooden covers and tarpaulins. In addition to these large hatches, there are a number of small hatches arranged to facilitate the stowage of grain in the wings, also hatches arranged above bunkers for coaling from upper deck.

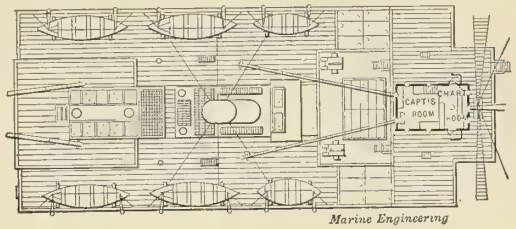
A steel center-line bulkhead is fitted between tank top and lower deck, extending from hatch to hatch, and bunkers are close-ceiled, and wooden sparring is fitted in the hold and in upper and lower 'tween decks. The

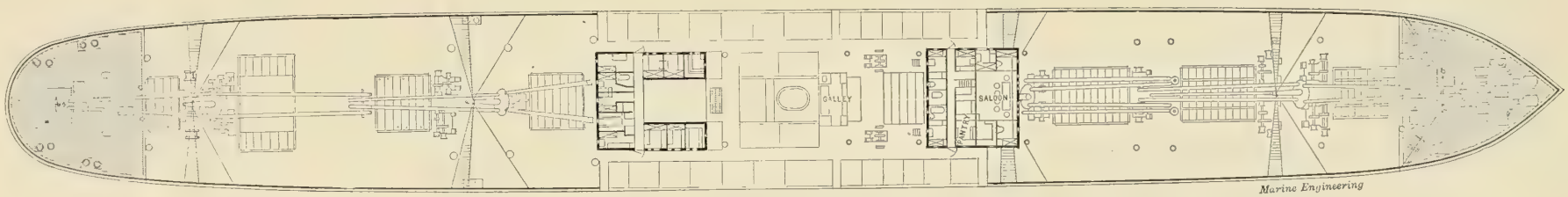


MIDSHIP SECTION ATLANTIC TRANSPORT SHIPS MISSOURI AND MAINE, BUILT BY THE MARYLAND STEEL COMPANY, SPARROW'S POINT, MD.

fittings are arranged to take shifting boards in way of hatches, also in lower 'tween decks. The bilges and coal sparring is omitted in deep tanks, as grain is carried in these compartments.







RIGGING AND SHELTER DECK PLANS OF THE NEW ATLANTIC TRANSPORT FREIGHT AND CATTLE STEAMERS MISSOURI AND MAINE.

Between the upper and shelter decks stalls are arranged for 632 cattle, with ports through side for loading and discharging. In addition to these, there is a cattle shelter deck for 125 feet amidships, above shelter deck, with stalls arranged for 118 cattle, making a total of 750 head. The cattle shelter deck is constructed with steel frames and beams and sheathed with 2-inch yellow pine, tongued and grooved. Complete cattle, fresh and salt water service, also fire pipes, steam pipes to winches and steering-gear shaft, are fitted under shelter-deck beams.

There are sixteen winches located on shelter deck, of Hyde make. The after winch has extended heads for warping and relieving tackle. Arrangements are also made to use the forward winch for warping. The windlass is a Hyde No. 13, and is located on the shelter deck, with a 16 by 12 inch engine on deck below. The steering engine, of Wilson and Pirrie type, is being made by

Harland and Wolff, and will be located on the upper deck, and operated by means of shafting and gears from stands in the pilot house and on shelter deck aft. The anchors, chains, and outfit are fully up to the requirements of Lloyds' rules. An anchor crane is fitted forward, of the government type. The bower anchors are stockless and will be stowed in the hawser pipes.

Four masts are fitted, of sufficient height to carry the cargo booms. On the masts are fifteen booms, three of these being of 20 tons capacity, the remainder of 8 tons. In addition to these there are four booms fitted in deck sockets, two between the fore and mainmast, and two aft of the forward deck house. All booms are of steel, and are arranged to step on tables built on masts.

The crew and cattlemen have quarters on the middle and upper decks forward, arranged with pipe berths and being fitted with ample toilets. The ice house and store rooms are located on upper deck on both sides of the steering gear. The captain has commodious quarters in the after end of the chart house. Under the chart house, and contained in a steel house, are the saloon, officers' quarters, toilets, pantry, bonded stores, and state rooms. The engineers have quarters alongside the engine-room casing on shelter deck, and the galley is arranged in the forward end of the boiler casing. The total crew consists of 108 people, and in all departments ample provision has been made for the berthing and messing of this number.

NAME—Missouri. NATIONALITY—American. BUILDERS—Maryland Steel Co.

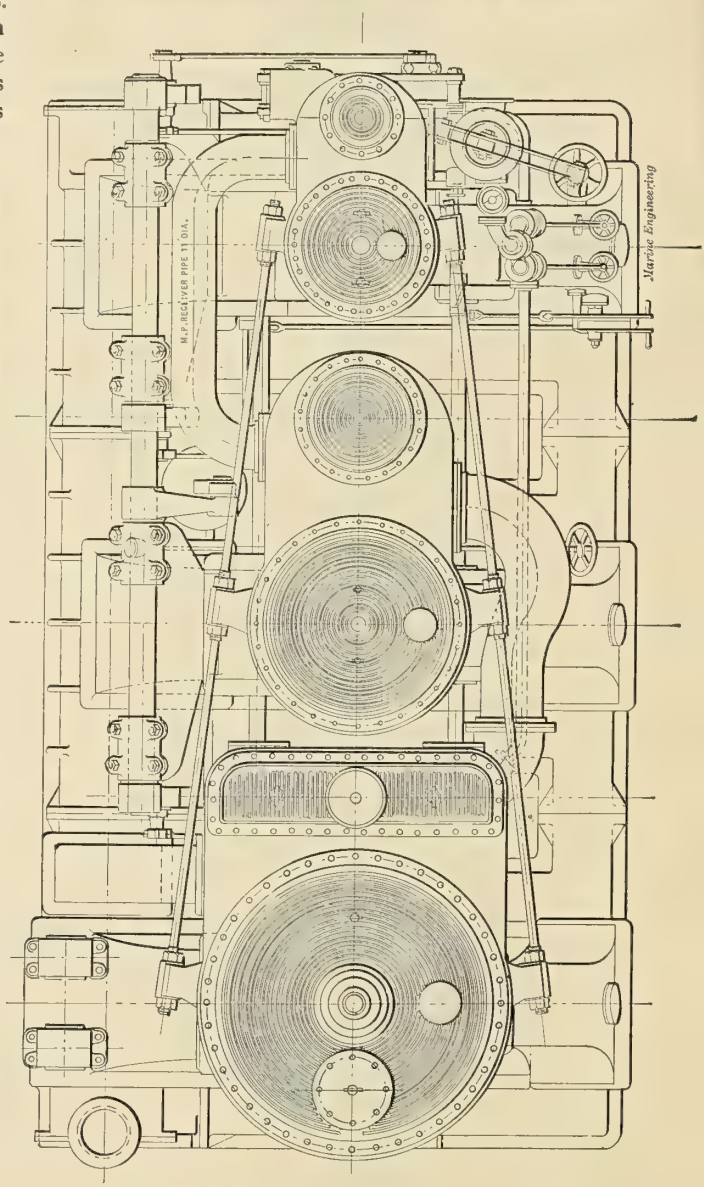
TYPE—Freight and cattle steamer. LAUNCHED— OWNERS—Atlantic Transport Co.

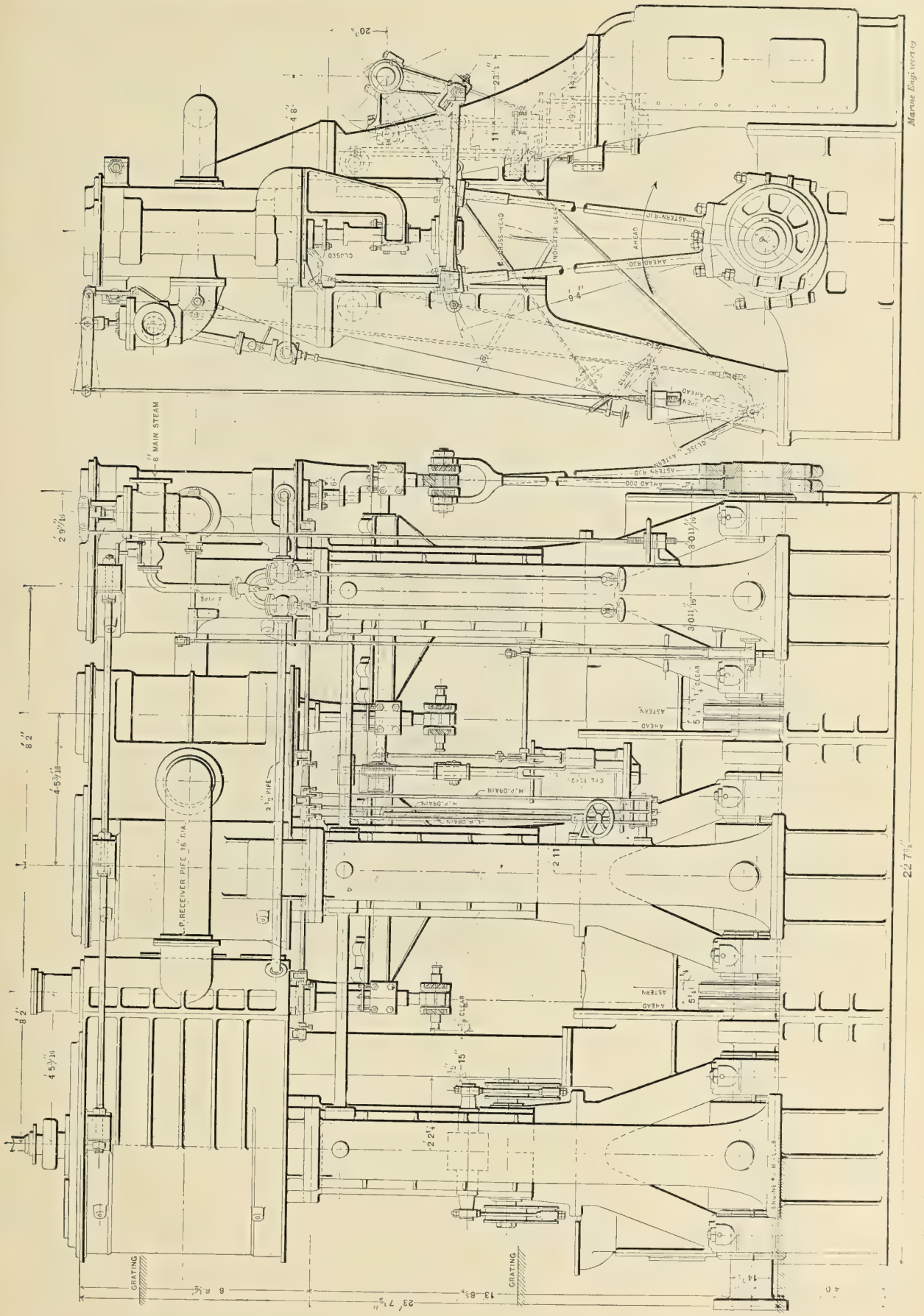
Length over all	507 ft.
" between perps	490 "
Beam, molded	58 "
Depth, molded, to lower deck	19 " 9 ins.
" " middle deck	27 " 7 "
" " upper deck	35 " 6 "
" " shelter deck	43 "
" " cattle shelter deck	50 "
" of water bottom	4 " 2 "
Draft, loaded	27 " 4 "
Displacement, loaded	17,200 tons.
Deadweight	10,400 "
Coal bunker capacity	1,300 "
Designed speed, loaded	12 knots.
Block coef	.78
Midship section coef	.97
Wetted surf	46,200 sq. ft.
Engines, number	2
Type	three-cylinder, triple.
Cylinder diameters	25, 42½, 72 ins.
Stroke	48 ins.
Valves	Piston on H. P. and I. P
Air-Pump, diameter	28 ins.
Stroke	20 "
Shafting line	14 "
Shafting crank	14¾ "
Condenser	Cast iron in engine frame.
Cooling surf., each	4,375 sq. ft.
Propellers, manganese bronze, number	2
Number of blades	4
Diameter	16 ft.
Pitch	19 " 6 ins.
Developed area	87.6 sq. ft.
Boilers, Two double-end, two single-end, Scotch.	
Diameter	15 ft.
Length	19 ft. 1 in.—10 ft. 8 ins.
Working pressure	200 lbs.
Furnaces	3 each end.
Diameter	43 ins.
G. S. total	314 sq. ft.
H. S. total	12,500 "
Draft	Howden system.
Two Sturtevant blowers, diam.	87 ins.
H. S. ÷ G. S.	40

ENGINES.

The twin screws are driven by engines having high-pressure cylinders 25 inches, intermediate cylinders 42 1-2 inches, and low-pressure cylinders 72 inches in diameter, with a common stroke of 48 inches. The cylinders of each main engine are cast separately, and tied together by means of forged steel rods at the top. The H.P. and M.P. cylinders are fitted with a hard, close-grained cast-iron liner and piston valves, and the low-pressure with slide valves worked by Stephenson link motion. The pistons are cast iron, of double section, and provided with Ramsbottom rings of cast iron, carried in removable cast-iron rings, with cast-iron follower rings, held down by large square-headed steel bolts.

The front and back columns are of box section cast iron; the back ones forming part of the condenser. The columns on the starting platform side are to be used as oil tanks, with lock cocks, and pipes leading to the deck. Guide plates of hard cast iron are bolted to each column, with water circulation at back of each go-ahead guide. The columns are tied together at top by forged steel




Marine Engineering
8" MAIN STEAM
L.P. RECEIVER PIPE 16" DIA.
2½" PIPE
3" PIPE
M.P. DRAIN
CYL. 15"x21"
CROSS-HEAD
INDICATOR RODS
AHEAD
ASTERN
CLOSED
GRATING
GRATING
TRIPLE-EXPANSION ENGINE. TWO OF THESE ARE BUILT FOR EACH OF THE NEW ATLANTIC TRANSPORT SHIPS UNDER CONSTRUCTION AT THE WORKS OF THE MARYLAND STEEL COMPANY.

rods. The condensers are of cast iron, well ribbed, and each has a cooling surface of 4,375 square feet. The bed plate is also of cast iron, of box form, with cross-bearers flanged and bolted to engine seating. The eccentric sheaves are of cast iron, made in halves, with straps of cast steel, lined with Parson's white metal.

The turning engine is fitted between the main engines and connected by means of clutches and gearing to the main shafts. The air and bilge pumps are worked off the low-pressure crosshead, and the fire, bilge, and sanitary pumps are independent and of the Admiralty type. The feed is of Weir type, and all other pumps are made by Blake.

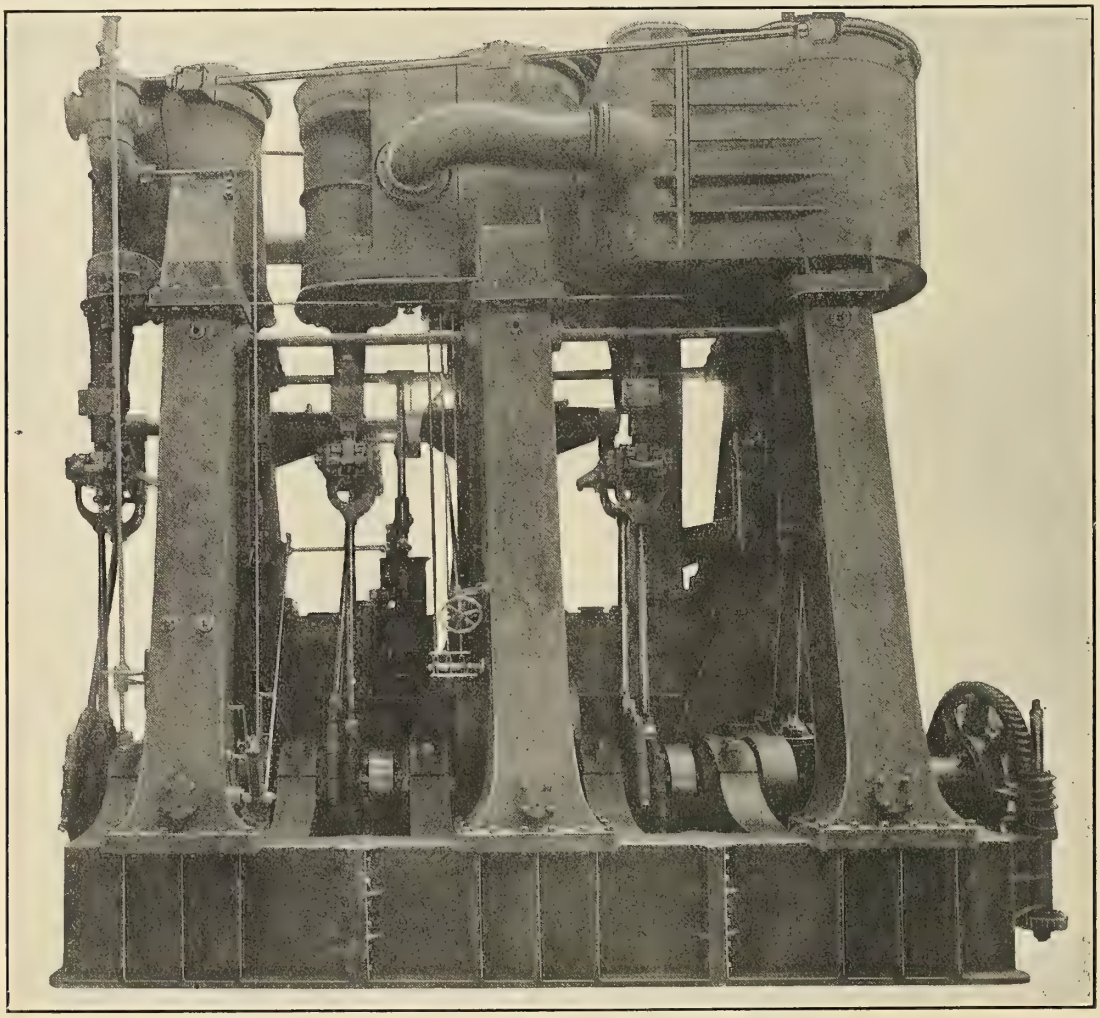
The evaporating plant consists of a Reilly evaporator, with a capacity of 35 tons of fresh water per twenty-four hours, and a distiller of 50,000 gallons capacity per twenty-four hours, together with a feed pump controlled by float in the chest attached to the evaporator. An auxiliary condenser is located in the engine room, and is of ample size to handle the exhaust from all winches, and is connected to a drain tank of ample size.

The shafting is of Siemens-Martin mild-forged ingot steel, in excess of Lloyds' requirements, and is enclosed to the stern tube with plating and frames bossed out to line of large steel casting forward of stern post. The crank shafts are interchangeable.

The stern tubes are of cast iron, the after end being carried by the hanger castings, and the forward end by the stern pipe bulkhead. The propellers are of built-up type, with hub of cast iron and four blades of manganese bronze.

There are two double-end and two single-end boilers of Scotch type, built for a working pressure of 200 pounds. A complete system of Howden forced draft is installed, the fans and engines being located in the engine room. The two Sturtevant blowers, with fans 87 inches in diameter by 24 inches wide, are each driven by a vertical compound single-acting engine 7½ by 13 by 6½ inches. Ash hoists are arranged in each fire room for lifting ashes through ventilator to upper deck. The ship is lighted throughout by electric lights, power being furnished by two 15 K.W. sets of the Sturtevant make.

The accompanying plans give a very good idea of the appearance of these ships when completed. The masts are rather shorter than has been the fashion, but are amply tall for handling derricks. Owing to the fire of the ways under these vessels, as described in October MARINE ENGINEERING, the work has been delayed.



ONE OF THE TRIPLE-EXPANSION ENGINES FOR THE STEAMSHIPS MISSOURI AND MAINE.

North German Lloyd Steamship Kaiser Wilhelm II.

The speed and size of the great liners of the North Atlantic, which have been continuously increasing since the first days of the steamship, are to be again eclipsed next season by the appearance of the new North German Lloyd express steamship the *Kaiser Wilhelm II.* This ship was launched from the Vulcan Company's yard at Stettin, Germany, last August, and it is expected she will be in service the coming season. A condensed table of dimensions of the latest liners is here given and serves as a basis of comparing the ships of the various companies.

The vessel has a complete double bottom divided into twenty-six water-tight compartments. There are sixteen transverse water-tight bulkheads extending to the upper deck, which is the molded deck, and a longitudinal bulkhead between the engine rooms. The capacity of these compartments is such that if any two of them were filled with water the ship would float. At the stern the framing is bossed out to take in the propeller shafts.

The upper deck is the fourth deck and above it are four other decks, the first being a spar deck right forward and aft. There is a forecastle, a midship house, and poop. The roof of the midship deck house extends over the full width of the ship and over the poop, forming an upper promenade deck 538 feet long. On this deck is built the upper promenade deck, 438 feet long, and over this is the boat deck.

A complete system of fire alarm bells is provided, as is also a complete fire-extinguishing installation. There are fifty-two water-tight doors in the bulkheads, and twenty-four of them are provided with the Dörr closing device by means of which they may be shut from the bridge. A bulkhead indicator in the chart house shows whether the doors are open or closed. When it is desired that the doors be closed from the bridge, alarm bells throughout the ship are sounded for twenty seconds previous to the closing. The doors may also be operated separately from each bulkhead.

The *Kaiser Wilhelm II* will have accommodations for 775 first-class passengers in the 290 cabins; 343 second-class passengers in 102 cabins; and 770 passengers of the third-class are carried on the main and lower decks. The ship's complement consists of 48 in the engine room, 229 in the boiler room, 231 in the stewards', and 45 in the deck department, making a total of 2,418 souls carried.

Of the many features of the first-class cabin are two very specially comfortable rooms called imperial suites, eight rooms de luxe, eight state rooms, and four chambers with separate baths and closet. The imperial suites consist of a saloon, breakfast room, sleeping room, and bath room, located on the upper promenade deck. The main dining saloon, which has a seating capacity of 554 passengers, is on the main deck, and the smoking room, reception room, reading and writing rooms are located on the upper promenade deck. On the boat deck are the children's room, café, and grill rooms. The second-class passengers are accommodated on the upper, lower, and main decks, aft. These cabins follow the lines of those of the first-class, except that they are not quite so elaborately decorated. The dining saloon, with seats for 190 persons, is on the main deck; reception and smoking rooms are at the after end of the promenade deck. As it is necessary to provide meals for so many people, very elaborate kitchens and pantries are to be found on board for the first and second cabins and the third-class passengers.

The ship has been built with a view of mounting, if necessary, a large number of guns in order to serve as an auxiliary in the Imperial German Navy. The deck equipment is of the very best and includes warping capstans, windlasses, etc. The launching weight of this ship was 11,200 tons, which is 1,900 tons greater than any other German ship launched.

	Builder.	Owners.	Length Over All.	Breadth.	Depth, Molded.	Gross Tonnage.	Draft.	Displacement.	Indicated Horse Power.	Highest Speed.
Kaiser Wilhelm II.....	Vulcan and Co.....	North German Lloyd.....	706 ft. 6 ins.	72 ft.	52 ft. 6 ins.	20,000	29 ft.	26,000 tons.	38,000	24 knots.
Kronprinz Wilhelm.....	"	"	663 "	66 "	43 "	15,000	29 "	21,300 "	36,000	23.5 "
Deutschland.....	"	Hamburg-American...	684 "	67 "	44 "	16,502	29 "	23,620 "	36,000	23.5 "
Kaiser Wilhelm der Grosse.....	"	North German Lloyd.....	648 " 7 1-2 ins.	66 "	43 "	14,349	28 "	20,880 "	30,000	23 "
Oceanic.....	Harland and Wolff	White Star....	704 "	68 " 5 ins.	49 "	17,274	32 " 6 ins.	28,500 "	27,000	20.7 "
La Lorain and *La Savoy*.....	.....	Transatlantic..	582 "	60 " 6 "	39 " 4 1-2 ins.	11,869	25 " 6 "	15,400 "	22,000	21.9 "
St. Paul and *St. Louis*.....	Cramp.....	American	554 "	63 "	42 "	11,629	26 "	16,000 "	18,000	21.08 "
Campania and *Lucania*.....	Fairfield Company.	Cunard.....	622 "	65 " 3 ins.	41 " 6 ins.	12,500	25 "	18,000 "	30,000	22.01 "

PROTECTION OF PROPELLER AND STERN-TUBE SHAFTS.

BY JOHN J. KING.

The protection of propeller and stern-tube shafts from galvanic action is a question which has engrossed the attention of engineers on account of the numerous failures of these parts without apparent cause.

In order to do this successfully some covering must be provided which will positively exclude the salt water from coming in contact with the shaft.

This is sometimes attempted by means of a loose tube or pipe of copper or brass slipped over the shaft, the ends butting against the composition sleeves on the shaft which form the bearings at stern tube or struts, the joints being sealed by a ring of soft solder.

Sometimes the composition sleeves are recessed and the joints made to overlap the tube and sealed, as in Fig. 1.

These are, however, very doubtful methods, as the soft solder will not last in salt water, but will soon be eaten away, thus leaving a free entrance for the water at the joints.

The writer has seen four stern-tube shafts, which were fitted like the first-mentioned method drawn, for examination, and in every case the solder was broken and cracked away from the composition bearing sleeve at the forward stern-tube bearing, leaving the joints open and water free to enter between the shaft and the tube forming the casing.

The breaking of the joint in this case was not due, however, to galvanic action, the vessels not having been afloat a sufficient length of time, but either to the difference in expansion of the shaft and sleeve covering, the "wringing" of the shaft, or in the handling in placing the shaft aboard.

In making the repairs to this casing the stern-tube bearings were drilled at A and A^1, Fig. 1, where they overlapped the casing. One end was then tapped to receive 3-8-inch pipe, and turpentine was pumped into the space between the shaft and its casing, running in at one end and out at the other until thought to be cleaned. Then one end was plugged, the bearing sleeves were calked down on the brass casing tube at the joints, and red lead putty was pumped into the space between the shaft and casing, the joint being finally sealed by a fillet of tin.

Another case which came to the writer's notice had the shaft covered in the stern tube by short lengths of brass tube, which were very likely soldered at the joints when first put on the shaft, but the joints were open when seen after the shaft broke. The engine at the time was running full speed ahead, with the pass-over to the low pressure open wide. The engineer had left the engine room when the shaft broke, and before the throttle was closed the cast-iron housings were broken top and bottom and a couple of the cylinder feet cracked.

A method usually employed on naval vessels is to cover the shaft with sections of short composition sleeves, as shown in Fig. 2, cast in lengths of 4 to 5 feet, which are shrunk on the shaft, the joints overlapping each other. Methods of making these joints are shown in Figs. 3, 4, and 5.

When the sleeves are rough turned sufficient metal

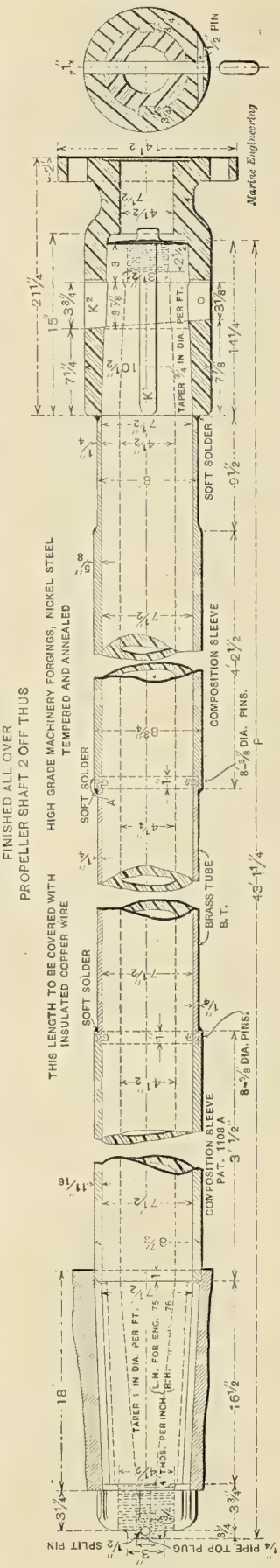

FINISHED ALL OVER
PROPELLER SHAFT 2 OFF THUS
HIGH GRADE MACHINERY FORGINGS, NICKEL STEEL TEMPERED AND ANNEALED
THIS LENGTH TO BE COVERED WITH INSULATED COPPER WIRE
SOFT SOLDER
BRASS TUBE B.T.
COMPOSITION SLEEVE
COMPOSITION SLEEVE PAT. 1108 A
8-7/8 DIA. PINS.
TAPER 1 IN DIA. PER FT.
TAPER 3/4 IN DIA. PER FT.
THDS. PER INCH
R.H. FOR ENG. 75 76
L.H.
1/4 PIPE TOP PLUG
1/2 SPLIT PIN
Marine Engineering

FIG. 1.

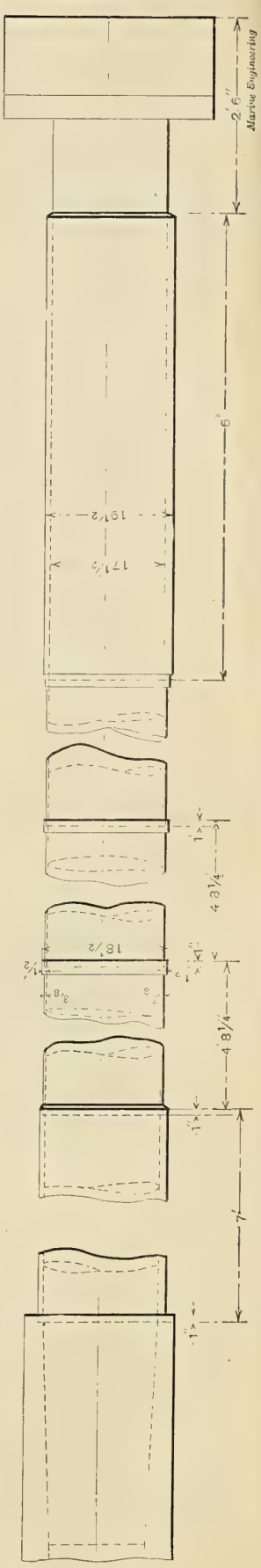


FIG. 2.

should be left to calk down and fill the recess between the joints caused by one sleeve shrinking away from the face of the sleeve next to it in cooling after being placed on the shaft. All iron chaplets in sleeves should be drilled out and plugged before being shrunk on. The after-bearing sleeve should make a water-tight joint with the propeller hub. Care should be taken that the keyways in the hub of the propeller do not extend deeper than the bottom of the recess at the forward end of the hub made to receive the shaft-bearing casing, as the water would then have a chance to run over the top of the key and thus reach the shaft. The same precaution should be taken in all outboard sleeve couplings, although these usually have a casing which is filled with rosin and pitch.

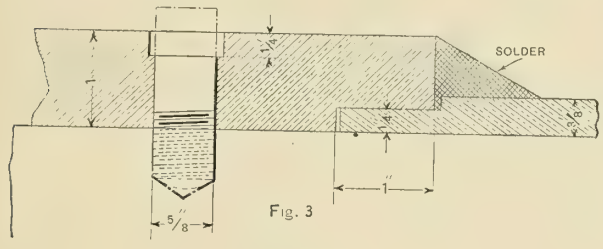


Fig. 3

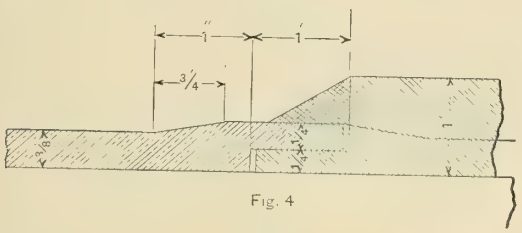


Fig. 4

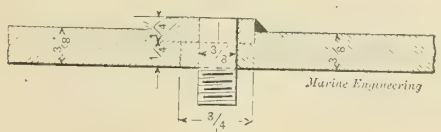


Fig. 5

The shell of the ship and stern tube is sometimes protected from the galvanic action due to these sleeves by serving the exposed composition with insulated copper wire or tape.

When the shafts are being placed aboard every joint should be examined before entering the stern tube, and if found cracked or open, which is likely to occur in handling if the shafts are long, they should be remedied.

President Roosevelt's Message.—In his annual message to Congress President Roosevelt makes a very earnest plea for the navy, recommending that the appropriation for gun practice be increased, as the only shots that count in battle are, he says, "the shots that hit." The lack of men and officers for the ships is also a serious question. In regard to increase of the navy, he recommends that there be no halt in the number of new vessels added each year, as the Isthmian Canal, while increasing the efficiency of our navy, will also require a larger-sized fleet. Although there is at present not the slightest chance of trouble with a foreign Power, the way to insure peace is to provide a thoroughly efficient navy.

RUNNING LIGHTS AND TELL-TALE DEVICES.

BY GEORGE MCQUILKIN, JR.

Since the safety of navigation depends at night on the continuous display of the running lights (that is, the side lights, masthead light, and sometimes the stern light, range light, towing lights, and the anchor light), it is necessary to give attention to these lights at frequent intervals in order that they may be continuously displayed. The ordinary types of lanterns are fitted with one or two lamps, to each of which is connected a double conductor cable through the medium of a receptacle, each lamp having its respective receptacle and switch, combined or separate, and a fuse, all of which are generally located near the lantern. The objection to the single lantern having only one lamp is that it requires more attention so that the lamp will not be extinguished for any appreciable length of time, and the delay in replacing the faulty lamp, while the objection to the double lamp is the impossibility of detecting when one lamp has been extinguished, except by close inspection.

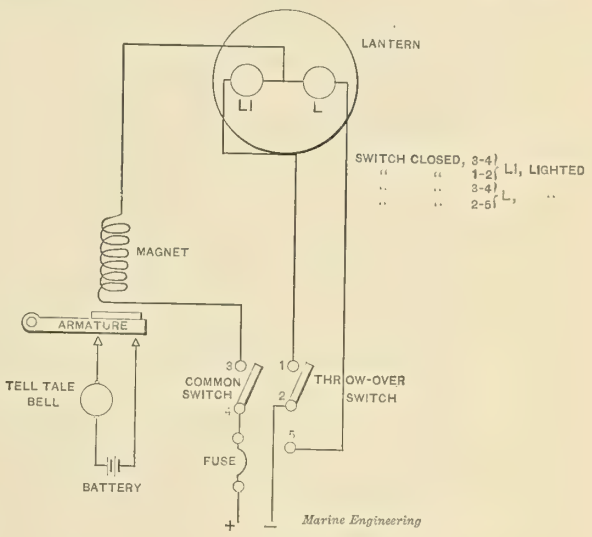


FIG. 1.

To avoid the necessity of attention and to afford a means of detecting when one lamp is extinguished, and to restore the lighting as quickly as possible, the following devices have been designed: The main features of the lanterns are the use of two lamp receptacles. One form has two receptacles on a filled wooden block mounted on the removable bottom of the lantern, and another type has two radial arms fitted so that the lamp may be brought out into the proper position in the lantern—that is, into focus with the lens, access to the lamps being had through a door on the side of the lantern. The latter type is probably the most endurable, being of metal parts, whereas in the former type the filled wooden block is likely to absorb moisture and swell, and therefore be difficult of removal from the case. Again, the block may be cracked by moisture, rendering it unfit for use. A good substitute for the wooden block is a composition plate raised to the same height as the wooden block, insulation being obtained by hard rubber inserted at the proper point.

The elementary diagram of wiring is shown in Fig. 1,

and is the principle of all the devices described. The lanterns each contain two lamps, and are fed from this device, which is generally located near the steering wheel station, through two switches. One is a single-throw switch common to all lamps, and the other a double-throw switch for each lantern. One clip of this double-throw switch is connected to one lamp, and the other clip connected to the other lamp, in the same lantern, so that when this switch is thrown up or down the lamp connected to the clip in contact is lighted and the other lamp extinguished. In the common wire, preferred, because if it were operated from the dynamo current and it failed there would not be power to operate the tell-tale bell or lamp. When a battery is used a switch is provided, so that the battery may be disconnected during the day in order that the bell may not run down the battery.

The type of device that the above description closely applies to is shown in Fig. 2. Another type that combines the audible and visible tell-tale is shown in Fig. 3. Assume that the lamp, *L*, Fig. 3, is burning, then current will flow from positive side through magnet,

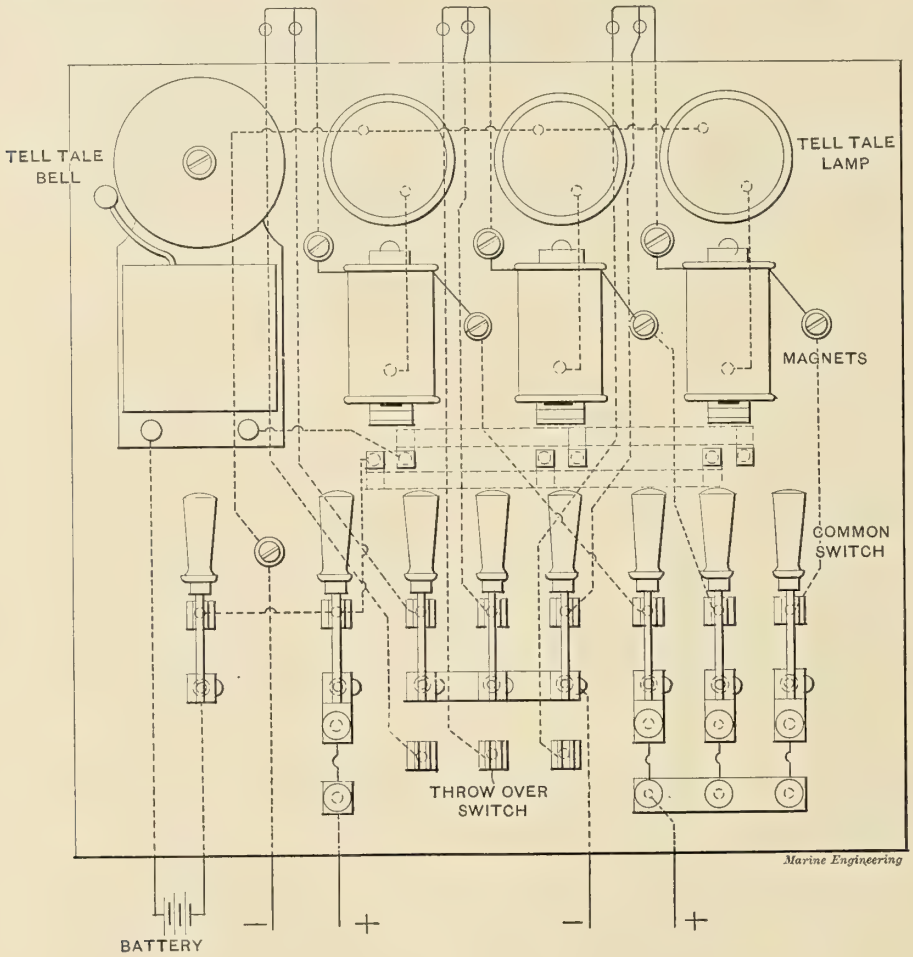


FIG. 2.

connected to the common switch, an electro-magnet is supplied by the current feeding the lamp, so that when either lamp is burning the magnet is energized and its armature attracted. When the current fails, due to the extinguishing of a lamp, the armature falls and makes contact with two points, thus closing the circuit connected to a bell or lamp, and indicating audibly or visibly until the current is sent through the magnet again. This can be accomplished by throwing the double-throw switch to the other position, when the extra lamp will be lighted, the magnet energized, and its armature attracted, thereby opening the bell or lamp circuit, which indicates that the lamp is burning. The burned-out lamp can then be replaced at convenience. In Fig. 1 the bell is shown operated by a battery. This is to be attracting its armature, thence to *Y*, to *X*, to lamp *L*, to 5 (switch is now closed across 2 to 5), to 2, to negative side. Lamp *L*1 will not burn, as its switch, 1 to 2, is open. The armature of the magnet will continue to be attracted as long as the cu[illegible] lamp *L*; but if this lamp should be extinguished, [illegible] current will cease flowing through the magnet, and its armature will be pulled by a spring until it strikes a point, *P*, and then the circuit is completed from positive, through magnet, to *Y*, to *X*, to *P*, through tell-tale lamp, to 2, to negative side. This lights the tell-tale lamp and attracts the armature of the magnet; but when the armature is attracted it breaks the circuit at *P*, and as the magnet is no longer energized, the armature is returned to *P* by the spring and the operation repeated. This making and

breaking of the circuit at *P* is very rapid, and causes a buzzing sound, giving the audible signal, and the tell-tale lamp, lighting each time the circuit is closed at *P*, gives the visible signal. It is obvious that if the dynamo current failed there would not be any signal given, as both the audible and visible tell-tales depend on the dynamo current for their operation, thereby rendering the tell-tale ineffective.

The snap switch is shown in the same side of the circuit as the throw switch. A better arrangement would be to connect the snap switch in the opposite side of the circuit, so that by opening the circuit at both of the switches the line to the lamps would be "dead." One type of device similar to the above, but using a single lamp, omits the throw-over switch, but retains the snap switch and adds the plug switch, so that, when the lamp is burning, by removing the plug the lamp may be tested, and this also secures the entire disconnection of the circuit from the device to the lantern. The double lamp is to be preferred, for the reasons stated above.

A double-lamp type of device retains the audible and visible signals, and also automatically replaces the extinguished light. Each lantern is fitted with two 32 c. p. lamps, and three wires are run from the indicator to the lantern. Under the indicator are fuses and switches for each lantern. All the lanterns are wired in a similar manner, and only the starboard lantern will be described. As the switches are turned on, lamp 1, Fig. 4, receives the current, and the magnet *M* is energized, lifting its armature, which carries the shutter, and the word "Burning" appears in its respective place on the face of the indicator. This leaves one lamp at this station in reserve. If lamp 1 is extinguished, or if the candle power is reduced, the indicating shutter for this lantern will show the word "Out," which means that the lamp 2 has been brought into the circuit, and this is further indicated by the vibrating of the alarm bell, and the tell-tale lamp over the instrument lighting up. The ringing of the alarm bell may be stopped by switching off the tell-tale lamp or by replacing lamp 1. This device is also fitted with a mechanical bell below the magnet *M*. The clapper for this bell is fastened to the armature, and in case of failure of the current supply the armature falls, and the clapper strikes the bell, giving the alarm; in which case the word "Out" appears on the face of the indicator.

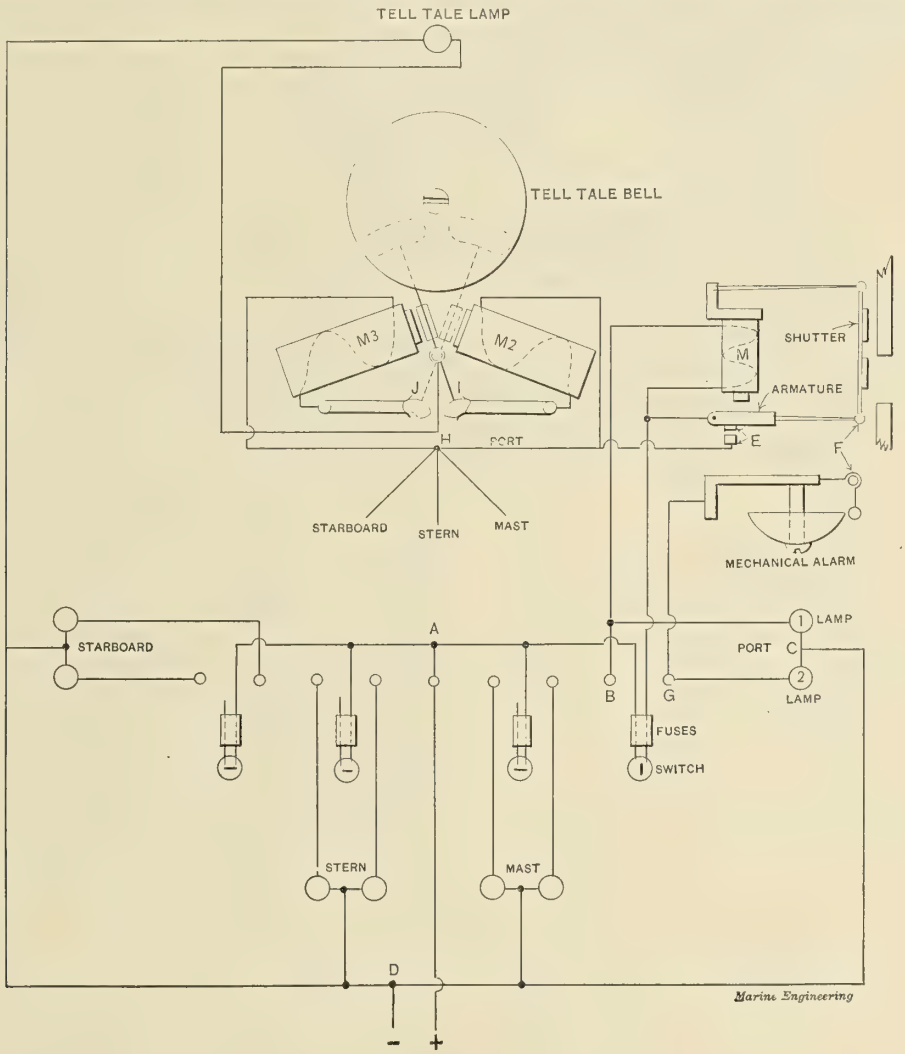


FIG. 4.

The wiring, Fig. 4, is shown for the starboard lantern, and is as follows: Starting at the positive side, to *A*, to fuse, to switch, through magnet *M*, to *B*, to lamp 1, to *C*, to *D*, to negative side, completing the circuit through the magnet *M* and the lamp 1. Magnet *M* lifts the armature, opening the circuit at *E* (leaving lamp 2 in reserve), which remains open until lamp 1 is extinguished. When lamp 1 is extinguished, armature drops and closes the circuit across *E*, and current flows from *E* to *F*, to *G*, through lamp 2, to *C*, to *D*, to negative side, and lighting lamp 2. Current also flows from *E* to *H*, through magnet M_2 (attracting armature of tell-tale bell), to *I*, through tell-tale lamp, to *D*, to negative side, lighting the tell-tale lamp. Armature of tell-tale bell is attracted

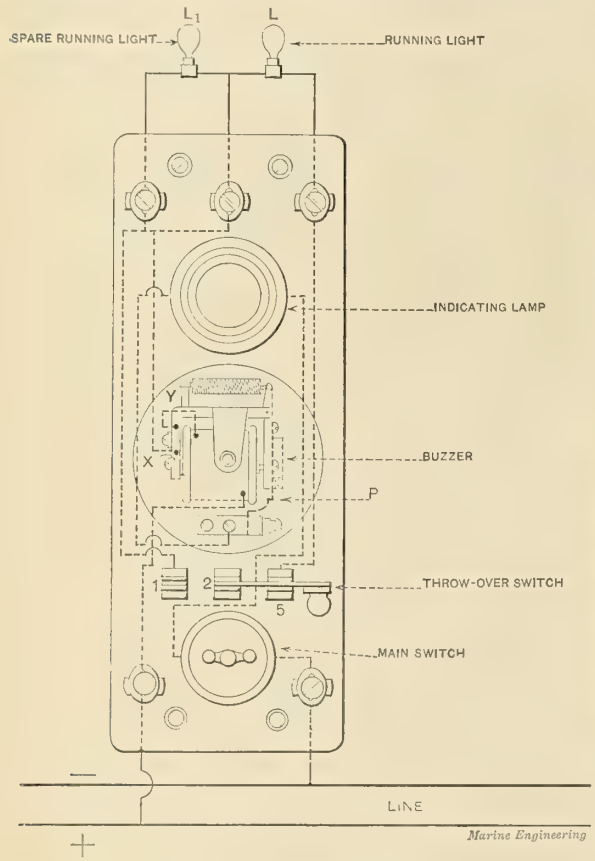
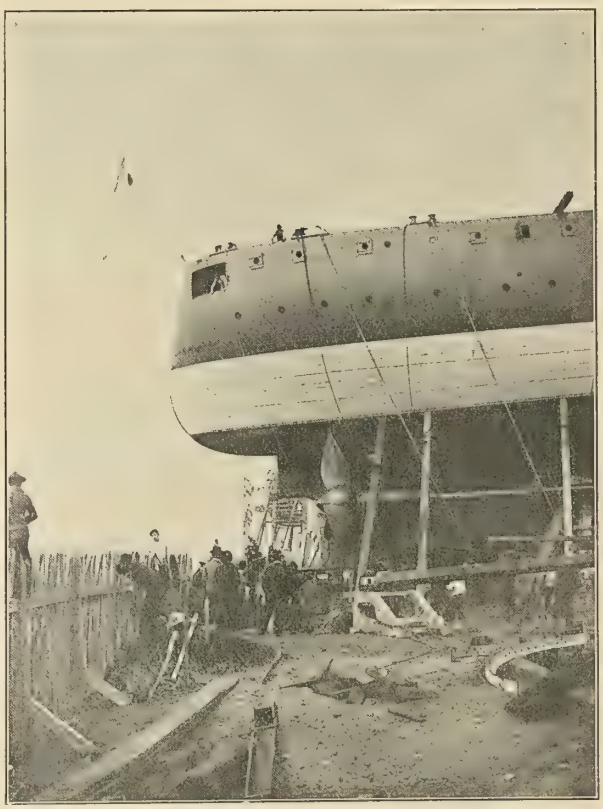


FIG. 3.

by magnet M_2, and is drawn into the position indicated by the dotted lines, and in moving to this position breaks the circuit at *I*, cutting out magnet M_2, and closing the circuit at *J*, sending current through magnet M_3, which attracts the armature in the same manner as magnet M_2, causing the vibration of the bell-striker. The action is similar to that in the case of the buzzer, Fig. 3. It is obvious that if lamp 1 were replaced, that magnet *M* would again attract its armature and open circuit at *E*, and stop bell ringing; or if it is not desirable to immediately replace lamp 1, the bell could be stopped by turning off the tell-tale lamp, which would open the circuit through the tell-tale bell. Obviously, then, if the tell-tale lamp were turned off, the circuit through the tell-tale bell would be open, and if another lamp burned out the tell-tale bell and lamp would not give a signal. The signal given would be the single stroke of the mechanical alarm when the armature dropped, and in case the extra lamp in the same lantern was extinguished no signal would be given, as the armature had already dropped for that lantern.

It is to be noted that in each type the magnets are supplied by the lamp current, and care should be taken that lamps of 32 c. p. are used in the lanterns, otherwise the magnets may not be energized sufficiently to attract their armatures—a 16 c. p. lamp consuming only one-half the current required by a 32 c. p. lamp.



STERN OF ARGENTINE BATTLESHIP RIVADAVIA.

Battleship Rivadavia, for the Argentine Republic.

Accompanied by interesting ceremonies, the battleship *Rivadavia* was launched from the yard of Messrs. Ansaldo and Company, Genoa, Italy, on October 22. Preceding the launch, the Catholic custom of dedicating the ship was observed by the Archbishop of Genoa, who pronounced a benediction on the vessel as she was about to go overboard. The keel plate was laid for this vessel March 10, 1902, making a record for quick work. In the accompanying table will be found the principal dimensions.

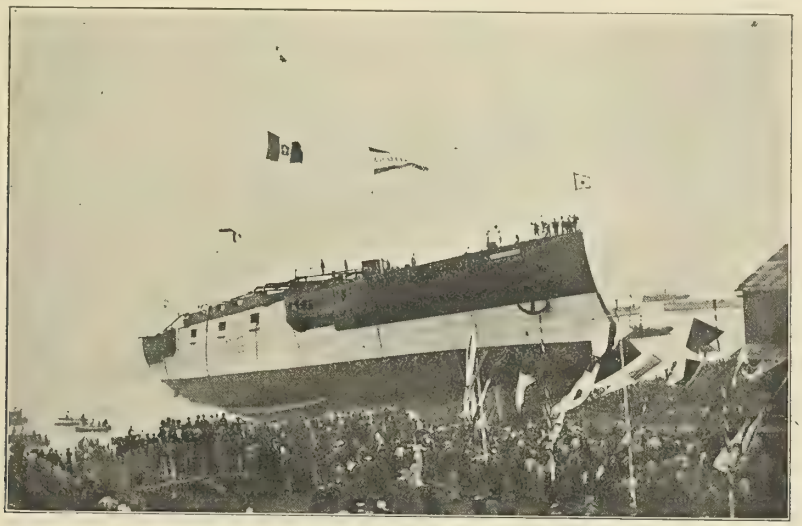
The armor encloses a central redoubt, extending for half length of the ship, of 6 inches thickness on the sides and 4 3-4 inches at the ends. The side belt extends 5 feet above the water line and the same distance below the water line, and outside the redoubt the side armor tapers to 3 1-8 inches at the ends. On the upper deck are two barbettes of 5 5-8-inch armor, one forward and one aft. The conning tower has 4 3-4-inch armor;

the protective deck is laid in two thicknesses of 1 5-8-inch plates.

The armament comprises one quick-firing 10-inch gun placed in the forward barbette, two 8-inch guns in the after barbette, and fourteen 6-inch rifles. The secondary battery includes ten 3-inch R.F.G., two automatic Maxim guns placed in the military tops, and four above-water torpedo tubes.

compartments forward and two aft. Forced draft is applied to the ashpits. The steam piping, which is of steel with cast-steel bends, comprises two main lines laid along each side of the vessel to the engine room and so fitted that both engines may be supplied from one or the other lines.

Electricity for lighting and power is provided by five 35-K.W. generating sets. The electric drive will be



LAUNCHING OF THE BATTLESHIP RIVADAVIA AT GENOA, ITALY, FOR THE ARGENTINE REPUBLIC.

A complete double bottom is fitted and under the machinery is divided into 44 water-tight compartments. The total number of water-tight compartments formed

FLOATING DERRICK WITH THE RIVADAVIA'S BOILER.

by the double bottom, transverse and longitudinal bulkheads is 250.

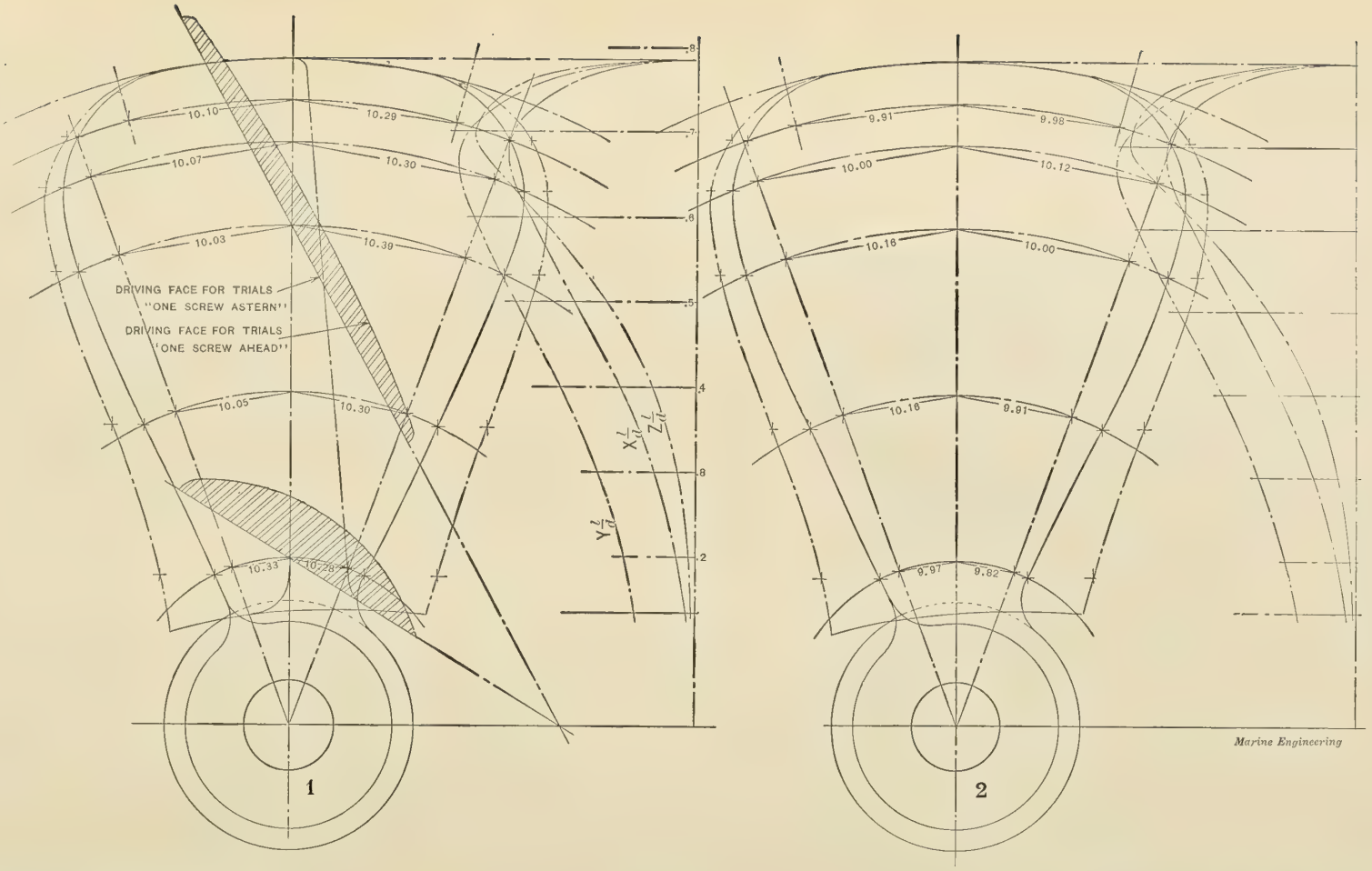
The motive power consists of two 3-cylinder, inverted, direct-acting, triple-expansion engines of dimensions given in the table. Steam is supplied at 165 pounds by four single-end and four double-end Scotch boilers. The two main engines are separated by a longitudinal bulkhead, the boilers are arranged in two

used for the guns, ammunition cars, and for many auxiliaries. The steering engines are of the Roger type, and the stockless anchor is of the Hall type. The estimated speed of this vessel is 20 knots, and the maximum coal supply of 1,100 tons will give a radius of action of 9,000 miles at 10 knots. Very little wood has been used in the construction.

The principal dimensions are:

Length over all	357 ft.
" between perpendiculars	344 "
Extreme beam	61 " 4 ins.
Depth	40 "
Mean draft	24 "
Displacement	7,700 tons
Launching weight	2,800 "
Engines, type	triple expansion.
Cylinder, diameters	42 1-2, 63, and 92 3-4 ins.
Stroke	46 "
Boilers, number	one-double end; two single-end.
Steam pressure	135 pounds
G. S.	893 sq. ft.
H. S.	24,272 " "
Condenser surface	6,910 " "
Designed I. H. P.	13,500
Estimated speed	20 knots

Testing the Hull of a Torpedo Boat.—The British Admiralty is experimenting with the torpedo-boat destroyer *Wolff*, to learn if she has sufficient strength to withstand the hogging and sagging strains received in the seaway. The torpedo-boat destroyer has been placed in dry-dock and lifted by a specially-built cradle at each end, the center being unsupported. The cradle was then placed amidships and the vessel raised clear of the ends. No defects were brought out, and the vessel will be taken to sea for further experiments.



Used in Both Single Screw Trials.
Stern Screw in Trials with Both Screws in Action.

EDGEWATER.

FOUR-BLADED CAST-STEEL PROPELLERS.

Bow Screw in Trials with Both Screws in Action.
This Screw Driving with Back of Blade.

	1	2
Disc area	50.27 sq. ft.	50.27 sq. ft.
Boss "	1.77 " "	1.77 " "
Developed "	31.98 " "	31.89 " "
Projected "	26.40 " "	26.37 " "
Pitch as measured	10.19 ft.	10.03 ft.
" " designed	9.75 "	9.75 "
Diameter	8.00 "	8.00 "

Contour and Pitch Measurements Are the Mean for All Four Blades.
Thickness Measurements from One Blade of Each Wheel, Averaged.

Taylor's Characteristics.

Scale for X & Y, $1'' = \frac{4}{10}$. For Z, $1'' = 2.$

	1	2
Area X $\frac{l}{d}$ curve	17.64 sq. in.	18.01 sq. in.
" Y $\frac{l}{d}$ "	27.21 " "	27.50 " "
" Z $\frac{l}{d}$ "	15.93 " "	16.69 " "
Value of X_c	.147	.150
" " Y_c	.227	.229
" " Z_c	.664	.695

PROGRESSIVE TRIALS OF THE SCREW FERRY-BOAT EDGEWATER.*

BY EDWIN A. STEVENS, VICE-PRESIDENT, AND CHARLES P. PAULDING, JR.

The only excuse the authors can give for the presentation of the results of the trials of the *Edgewater* is the value of data of this class to designers.

Three sets of trials were run—1st, with one screw astern; 2d, with the same screw ahead; 3d, with both screws.

Similar trials, as far as the authors are aware, have been run in but two other instances—those of the *Bergen,* recorded in Vol. XI. of the Transactions of the Society of Mechanical Engineers, and of the *Cincinnati,* recorded in Vol. IV. of the Transactions of this Society. Of the former it can only be said that, as their main object was the determination of steam consumption, the speed data did not receive enough attention to insure reliable results. The trials of the *Cincinnati,* however, were most carefuily run.

The result of the greatest interest in the *Edgewater's* trials is the low resistance of the hull as compared with similar vessels. Full speed in ordinary service is about 10 1-2 knots.

The following is the approximate performance of several vessels of this class at about that speed:

Name.	W. L. Length.	Displacement.	Block Coef.	Slip.	Adm. Coef.
Bremen	217	900	.34	16	154
Cincinnati.	200	952	.42	18.5	133
Netherlands	203	825	.36	18.5	144
Edgewater	173	687	.42	14.5.	173

The above data are close approximations only. It is to be remembered that low resistance is not as important in these vessels as in most others, and may well be sacrificed to other elements of design. It is also to be remarked that the trials of the *Bremen, Cincinnati,* and *Netherlands* were run with screws since shown to have been of unsuitable design. Notwithstanding this fact, the authors would call attention to the close relation between slip and performance in these vessels. The similarity between the curves of Admiralty coefficient and of slip in the *Edgewater* is specially marked.

In the following appendix are given a description of the vessel, an account of the trials, and the method of observation and calculation. The tables attached give a full log of the trials:

APPENDIX.

Dimensions of *Edgewater:*

Length on water line	173 ft.
Beam on water line	34 ft.
Draft to base on trial	9 ft. 6 5-8 in.
Displacement to base on trial	687 tons.
Wetted surface to base on trial	5,764 sq. ft.
Propellers—diameter	8 ft.
" pitch, bow	10.03 ft.
" " stern	10.19 ft.
" projected area, each	26.4 sq. ft.

*Read at the November, 1902, meeting of the Society of Naval Architects and Marine Engineers.

Contract trials were run without cleaning bottom or any special preparation. A speed of 13.78 statute miles an hour was obtained as the mean of four runs with about 150 revolutions. The greater number of revolutions needed for that speed in these runs as compared with the progressive trials may have been due to any one or all of the following causes:

1. Slightly greater displacement.
2. Foul bottom.
3. Error in steering course; the buoys hereinafter mentioned were not used in the contract trials.

Before undertaking the progressive trials herein described the vessel was dry-docked and cleaned, but not painted, as the paint was quite new; and the next day the progressive trials with one screw astern were run. On the following day a similar set of trials was run with the vessel turned about, the screw being ahead and pulling the vessel instead of pushing it. After docking to replace the bow propeller, the trials with both screws in action were run.

The draft of the vessel was practically the same in all the trials. The course was 5,280 feet long in the Delaware river near Wilmington and directly off Deep Water Point. It had been surveyed several times by competent surveyors. The mean depth of water during the trials was in the neighborhood of 5 to 6 fathoms.

Each end of the course was marked by conspicuous range poles, and the longitudinal range was marked by buoys at the ends of the course. The routine of each of the three sets of progressive trials was identical with the same observers at the same posts; they had been previously drilled at the contract trials of the vessel.

The chief observer, stationed in the forward pilot house, started his stop-watch on entering the course, and at the same time pressed the button of an electric connection to the recording revolution counter in the engine room. He recorded each minute on the counter, and finally the moment of leaving the course, when he also stopped his watch. In this way the determination of the speed and revolutions, or, in other words, the slip and revolutions per minute, contained the personal error of only one man. The work of this observer was checked, as regards time on the course, by another observer in the pilot house and by the attendant at the recording counter in the engine room, who timed the click of the magnet; and as regards the total revolutions, by a man at the regular engine counter, who took readings by bell signals given by a third observer in the wheel house. The recording counter was simply a paper drum, belted to the propeller shaft and provided with suitable gearing, and a punch actuated by a magnet. It was calibrated from the engine counter immediately after each day's trials. It was found to have the same rate for any speed of the engine, the slip of the belt, if any existed, being constant.

The three stop-watches used were afterward carefully rated; one was sensibly correct, and the errors of the other two constant. The agreement between the two deck observers' timing, as corrected for the errors of the watches, is shown in the log sheets given elsewhere in this paper. There were three men at the indicators and a fourth to supply them with cards and give them signals. From four to seven sets of cards were taken on each run. The observer in general charge in the engine room saw to it that the speed of the engines was

constant during each run, and as near the desired rate as was practicable. This duty would have been much less laborious if a tachometer had been attached to the engine where the engineer could easily see it.

The speed-revolution curves given on Plate I. were worked up by the method described in a paper on Tidal Corrections, which forms part of Vol. VII. of the Transactions of this Society.

The tide curves incidental to this method are given on the same plate. The slip curves follow directly from the pitch of screws and the speed-revolution curves. M.E.P.'s between cards from runs with and against the wind. The mean value with and against the wind for each speed was used in plotting M.E.P. curves; the spots from the average for each run were then plotted and found to agree.

The speed on Plate I. is in statute miles, this being convenient on account of the length of the course. On Plate II. the speed is in knots, the revolution curves and slip curves are taken directly from Plate I., and the power curves were drawn by calculation from the M.E.P. curves of Plate I. The spots in all cases leave

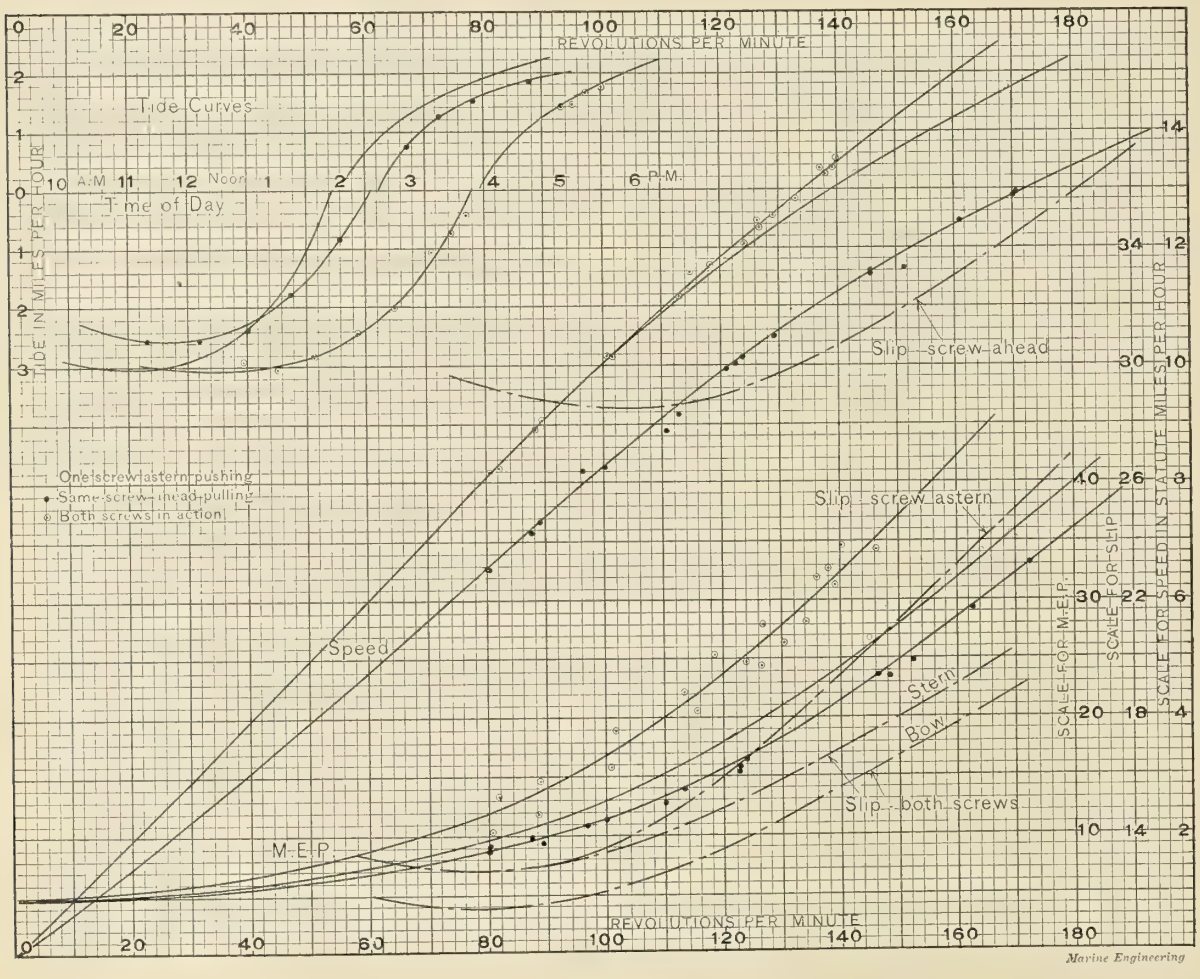


PLATE I.

The spots for the M.E.P. curves were obtained by averaging the cards taken each run, and plotting the average M.E.P. reduced to the low-pressure cylinders on the average revolutions for the cards. This latter figure was obtained from the recording revolution counter, a pencil mark having been made on the counter card at the moment of taking each set of indicator cards.

The punch marks made each minute on the counter card served to determine very closely the rate of turning at the time any indicator card was taken. This work was checked very satisfactorily by grouping all the cards at the same speed.

Decided differences were found at each speed in the little chance for variation in the drawing of the faired curves.

The irregularity of the M.E.P. spots for the trials with both screws is only apparent. The high spots are for the runs against the strong wind, and the low for those with it. The M.E.P. spots were plotted on both sides of the zero revolution ordinate, and battens laid through the spots.

In this way these curves were continued down to zero revolutions. The initial friction thus determined is extremely high. Indicator cards would have been taken at lower revolutions if time had permitted. While this friction may be lower than shown on Plate I., that very considerable initial friction existed is evident from the

form of the Admiralty coefficient curve at the lower speeds. This was also shown by the fact that trouble was experienced from heating.

Annual Report of the Commissioner of Navigation.

The annual report of the Commissioner of Navigation shows that on June 30, 1902, the documented tonnage of the United States was the largest in our history, comprising 24,273 vessels of 5,797,902 gross tons. The increase over last year is almost wholly in large steel steamers, built by few shipbuilding plants for few shipowners. In ten years the number of American, British, and German square-rigged vessels has decreased 50 per cent. Tonnage registered for foreign trade shows a slight and unexpected decrease of 6,574 tons, which is more than offset by its increased efficiency as steamers supersede sail vessels. American vessels carried 8.8 per cent. of our exports and imports, compared with 8.2 per cent. in 1901.

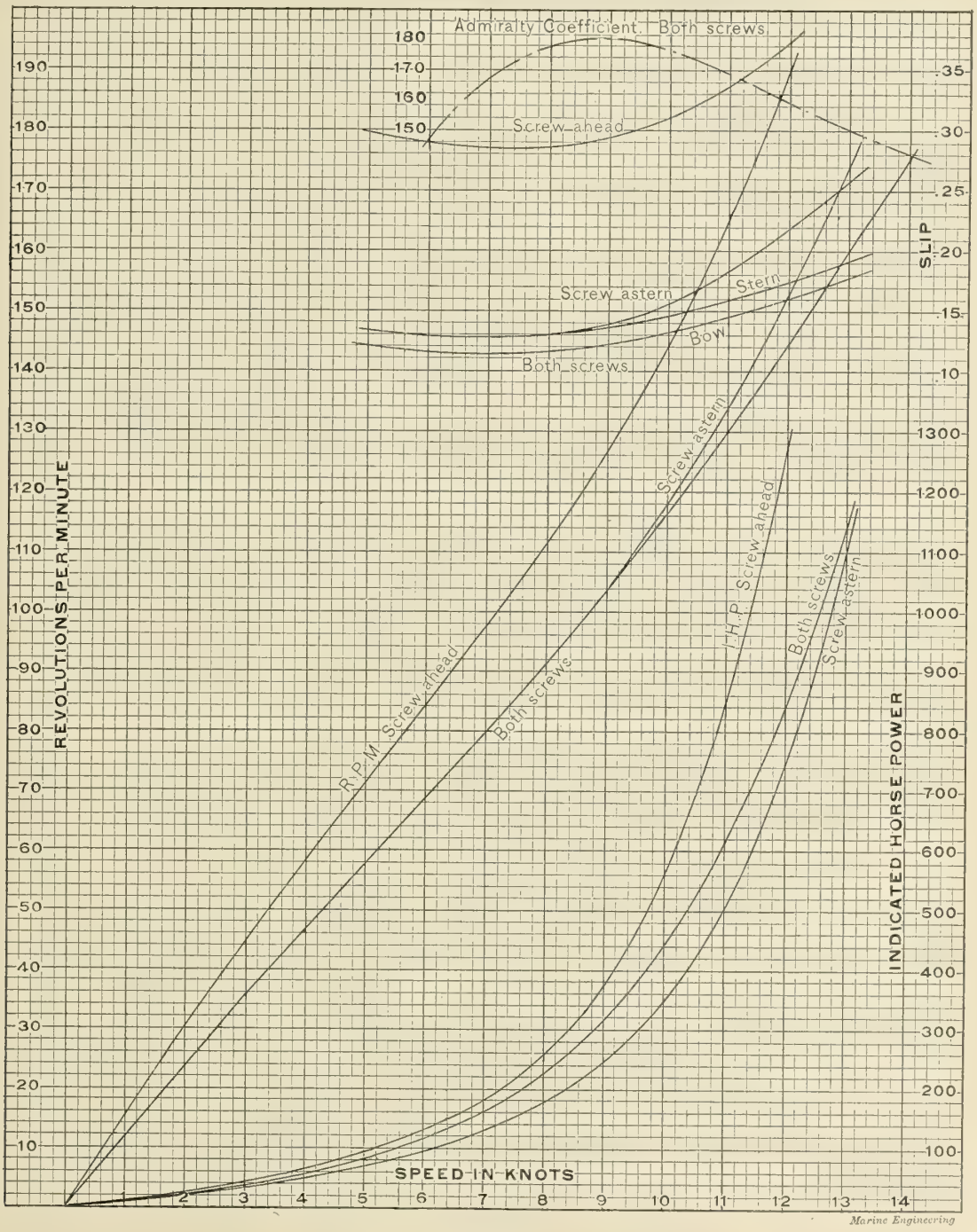


PLATE II.

The outlook for steel shipbuilding in the United States for the current fiscal year is not so promising as was last year's, but the same is true of Great Britain, where 1,000,000 tons of steel vessels were building on Sep-

tember 30, 1902, compared with 1,400,000 tons on September 30, 1901. On July 1, 1902, there were building or under contract in the United States 347,500 tons of steel merchant vessels. A large percentage of the total has been finished in the first quarter of the year, and no new large contracts on the seaboard are reported.

1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
No. of Run and Direction.	Approximate time of start.	Time on the mile. A M. S.	Time on the mile. B M. S.	Mean time of A and B in minutes.	Total revolutions by recording counter.	Revolutions per min. from columns 4 and 5.	Total revolutions from engine counter.	Steam at start.	Steam at finish.	Vacuum at start.	Vacuum at finish.	Mean time of day for pair of runs.	Mean tide for pair.	Mean time of day for each run.	Mean tide for each run.	Apparent speed in statute miles.	True speed in statute miles.	M. E. P. high press.	M. E. P. low press. "A."	M. E. P. low press. "B."	M. E. P. referred to low.	R. P. M. for cards.	I. H. P.
1 D	11·05	8·02⅜	8·02	8.04	983	122.2	996	137	135	24	24			11·09	2.55	7.46	10.01	30.17	7.64	7.42	15.57	122.8	324.0
2 U	21	4·43⅝	4·43	4.72	584	123.7	588	133	135	24	24	11·15	2.56	23	2.57	12.71	10.14	31.56	8.12	8.00	16.47	124.0	346.2
3 D	44	9·29¾	9·29⅜	9.49		110.7	1050	134	134	23.2	23.2			50	2 56	6.32	8.88	24.95	6.32	5.98	12.80	110.2	239.1
4 U	12·06	5 09	5·08⅝	5.15	581	112.8	584	134	135	23	22.7	11·58	2.57	12·09	2.51	11.65	9.14	27.07	7 02	6.55	14 00	113.5	269 6
5 D	25	10 10⅛	10·11	10.18	1019	100.1	1025	136	133	22.3	22			30	2.37	5.89	8.26	22.82	5.50	5.22	11.44	100.0	194.0
5 U	48	5·46⅛	5·47	5·78	558	96.5	562	137	135	22.6	22	12·39	2.39	51	2.18	10.38	8.20	21.25	5.10	5.05	10.74	96.7	176.0
6 D	1·03	11·28⅝	11·28⅜	11.47	1006	87.7	1011	135	135	22.7	23			1 09	1.92	5.23	7.15	19.54	4 78	4.58	9.88	87 2	146.0
6 U	25	6·44⅛	6·44⅝	6.74	600	89.0	605	136	137	22.4	22.3	1·17	1.78	28	1.57	8.90	7.33	18 39	4.47	4 32	9.30	89.2	140.6
7 D	44	10·56⅜	10·57⅜	10.95	881	80.5	889	136	136	22.3	22			49	1 06	5.48	6.54	17.71	4.50	4.23	9.09	80.2	123 5
8 U	2·05	8·26⅜	8·26⅞	8.44	676	80.1	681	134	135	21.7	21.7	1·59	.83	2·09	.54	7.11	6.57	17.55	4.12	3.96	8.72	80.0	118.2
9 D	45	5·43⅝	5·43⅞	5.72	691	120.9	695	133	135	23	22.8			48	.56	10.49	9 93	28.41	7.77	7.65	15.28	122.6	317.9
9 U	57	6·13⅛	6·13⅝	6.22	802	129.0	807	127	127	24	23	2·55	.75	3·00	.84	9.65	10 49	.....	.....	.....	.....	.	.....
10 D	3·12	4·43	4·42⅝	4.72	686	145.4	687	130	126	24	24			14	1.11	12.71	11,60	44.07	11 95	11.68	23.56	146.5	585.0
10 U	·27	.....	5·52	5.87	855	145.6	860	127	126	24	24	3·22	1.26	30	1.32	10 22	11.54	43.88	12.07	11.55	23.50	148.5	592.0
11 D	41	4·34⅛	4·34⅝	4·57	691	151.2	692	133	127	23 9	24			43	1.46	13.13	11.67	46.33	12.75	12.22	24 84	152.3	641.5
11 U	55	5·31⅝	5·32	5 53	890	160.9	896	132	121	23	23	3·51	1.51	58	1 60	10.85	12 45	53.71	15.35	14 70	29.33	163.0	811.0
12 D	4·20	4·06	4·06	4.10	696	169.8	699	125	115	19 5	22			4·22	1.76	14.64	12.88	.	17.86	18.14	.....	171.3	.....
12 U	50	5·27⅛	5·27⅜	5.46	930	170.4	935	125	95	22	24	4 38	1.84	53	1.96	10.98	12.94	62 33	17.58	16.90	33.16	172 5	970.0

EDGEWATER.

Progressive Trials. One screw ahead pulling. April 24, 1902.

Mean measured pitch of screw, 10.19 feet. Light wind, smooth water. Mean trial draft, 10 feet 1¾ inches. Corresponding displacement, 687 tons. Wetted surface, 5,764 square feet.

1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
No. of Run and Direction.	Approximate time of start.	Time on the mile. A M. S.	Time on the mile. B M. S.	Mean time of A and B in minutes.	Total revolutions by recording counter.	Revolutions per min. from col's 4 and 5.	Total revolutions from engine counter.	Steam at start.	Steam at finish.	Vacuum at start.	Vacuum at finish.	Mean time of day for pair of runs.	Mean tide for pair.	Mean time of day for each run.	Mean tide for each run.	Apparent speed in statute miles.	True speed in statute miles.	M. E. P high press.	M. E. P. low press. "A."	M. E. P. low press. "B."	M. E. P. referred to low.	R. P. M. for cards.	I. H. P.
1 D	12-25	6-57	6-57	6.95	821	118.2	826	115	105	23.8	24.1			12-28	3.06	8.64	11.70	47.14	12.90	12.62	25.32	118.8	510.5
2 U	44	3-59	3-58⅝	3.58	493½	124	492	105	103	23.8	23.6	12-36	2.93	46	3.02	15.08	12.06	46.43	12.10	12.44	24.64	124.0	518.2
3 D	55	7-18⅛	7-20⅝	7.33	828	113	831	104	110	23.6	23.7			59	2.98	8.18	11.16	40.22	11.16	11.54	22.07	113.4	424.4
4 U	1-14	4-08⅜	4-09	4.14	475½	114.8	480	126	116	23.8	23.5	1-05	3.06	1-16	2.93	14.49	11.56	38.22	10.26	10.46	20.55	115.7	403.0
5 D	23	8-16⅜	8-17⅝	8.29	841½	101.5	845	120	132	24.0	22.8			27	2.87	7.24	10.11	35.25	9.44	9.64	18.93	101.8	327.0
6 U	43	4-39⅜	4-39⅝	4.66	469	100.6	472	135	137	23.3	22.0	1-35	2.86	46	2.75	12.88	10.13	30.38	7.70	7.75	15.82	101.0	271.0
7 D	59	9-17⅝	9-17⅞	9.29	833	89.7	838	132	134	24.8	25.0			2-04	2.57	6.46	9.03	26.21	7.66	7.64	14.63	88.8	220.5
8 U	2-20	5-30⅝	5-20¼	5.34	472½	88.5	475	138	136	25.1	24.7	2-12	2.45	23	2.32	11.23	8.91	21.72	6.04	6.02	11.82	88.5	177.3
9 D	30	9-52⅝	9-54	9.88	811	82.1	816	137	136	23.0	24.8			35	2.17	6.07	8.24	24.24	6.94	6.86	13.36	81.8	185.4
10 U	50	6-03⅜	6-02⅝	6.05	486	80.4	490	133	138	23.5	23.3	2-43	2.01	53	1.80	9.92	8.12	19.75	5.22	4.90	10.32	80.5	140.8
11 D	3-01	5-25⅝	5-26⅜	5.44	688	126.4	694	132	125	24.2	25.0			3-04	1.42	11.03	12.45	49.98	14.54	14.70	27.94	127.0	602.0
12 U	23	4-21⅜	4-21⅝	4.36	579	132.7	582	132	127	24.6	24.3	3-14	1.06	25	.92	13.76	12.84	50.50	14.40	14.80	28.05	134.3	639.5
13 D	34	4-38⅝	4-38⅞	4.64	648	139.6	653	133	121	24.2	24.6	3-31	.75	36	.58	12.93	13.51	60.68	18.32	18.50	34.58	140.5	824.0
14 U	4-20	.....	.....	....	....	.....	...	...	...	....	....	3-45	.44	....	....	.....	.....	70.59	15.60	15.44	34.33	146.5	853.0
15 D	52	4 59⅛	4-59⅛	4.99	695	139.1	699	113	103	23.7	24.5	4-59	1.42	4-55	1.33	12.03	13.36	56.03	16.24	16.28	31.18	139.2	736.0
16 U	5-02	4 04⅜	4-04⅝	4.08	562	137.8	565	102	100	24.1	24.0	5-10	1.45	5-04	1.44	14.71	13.27	58.63	16.70	17.40	32.69	138.3	767.0
17 D	13	5 34⅝	5-34⅞	5.58	708	126.8	712	105	106	24.8	25.0	5-22	1.67	16	1.60	10.75	12.35	46.35	12.00	12.18	24.44	126.8	526.0
18 U	27	3 58⅜	3-59	3.98	545	137	554	112	102	24.3	24.0	5-35	1.78	29	1.73	15.08	13.35	58.10	16.26	16.60	31.92	136.3	738.0
19 D U	38	5 35	5-35	5.58	720	129	725			24.2	24.3			42	1.82	10.75	12.57	49.19	13.12	13.52	26.43	130.5	584.5

EDGEWATER.

Progressive Trials. Both Screws. April 26, 1902.

Mean measured pitch, of bow screw, 10.03 feet; stern screw, 10.19 feet. Vessel docked after trial of April 24 and screw replaced at engine end. Stiff wind, lumpy water; wind decreased somewhat during trials.
Trial with engine end ahead. Mean trial draft, 10 feet 1⅝ inches.
Corresponding displacement, 687 tons. Wetted surface, 5,764 square feet.

The report contains a review of the crews (excluding masters) required to man the seagoing vessels of the

United States of over 100 tons, foreign and coasting trades combined. In round numbers American seagoing steamers require 24,000 men, American square-rigged vessels 6,000 men, and American schooners 10,000 men. Crew lists indicate that 21,000 are Americans born or naturalized, and 19,000 are foreigners.

Last year 2,122 ocean steamers of 7,300,000 gross tons, including several hundred small tramp steamers, entered American ports in foreign trade. The export, import, and passenger business of the United States would require the continuous employment of 1,350 steamers of 4,900,000 tons, or over 20 per cent. of the world's foreign-going steamers. We employ, however, 40 per cent. of the large and fast steamships of the world. Speed is less useful to commerce than great size in steamers, but American trade exacts both.

The report prints at length the agreement of the transatlantic merger and its fleet of over 1,000,000 tons. The organization of so great a navigation company under American auspices is, however, the most important step toward the establishment of the influence of Americans on the ocean which has been taken since, through the rebuilding of the navy, modern shipbuilding plants were developed in the United States. The relations of the merger to the trade of the United States will be exceptional, the only parallel being the relations of the two great German lines to Germany's commerce.

Since 1894 steamers in the foreign trade of the United States under foreign flags, but owned by a large—probably a majority—interest of American capital, have increased from 200,000 tons to over 1,000,000 tons. In the same interval steamers under American register, including those in Hawaiian trade, have increased from 224,000 tons to only 398,000 tons. The policy of subsidies is the only method at the present time by which American-built steamers with American crews can obtain any considerable share of foreign trade. The repeal of compulsory pilotage on sail vessels in the coasting trade and minor changes in the navigation laws are recommended.

The report reviews the world's ocean steamship commerce for 1901 on the basis of reports of steamship companies owning about 40 per cent. of the tonnage in the world's foreign and colonial trade. These reports indicate that the world's foreign-going steamers in 1901 were valued at about one billion dollars, and that gross receipts were about $850,000,000, out of which $50,000,000 in dividends and $9,000,000 interest on bonds were paid.

1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
No. of Run and Direction.	Approximate time of start.	Time on the mile.		Mean time of A and B in minutes.	Total revolutions by recording counter.	Revolutions per min. from columns 4 and 5.	Total revolutions from engine counter.	Steam at start.	Steam at finish.	Vacuum at start.	Vacuum at finish.	Mean time of day for pair of runs.	Mean tide for pair.	Mean time of day for each run.	Mean tide for each run.	Apparent speed in statute miles.	True speed in statute miles.	M. E. P. high press.	M. E. P. low press. "A."	M. E. P. low press. "B."	M. E. P. referred to low.	R. P. M. for cards.	I. H. P.
		A M. S.	B M. S.																				
1 D	10-29	lost.	7·16	7.27	833	114.6	836	140	133	22.5	23.5			10-33	3.02	8.25	11 27	33.61	7.58	7.56	16.53	115.1	322.4
2 U	53	4-02½	4-02	4.04	487½	120.7	491	133	133	22.2	22	10-43	3.00	55	3.07	14.85	11.78	35.02	8.12	....	17 45	121.2	358.5
3 D	11 03	6-42½	6-42	6.71	823	122 7	829	132	131	22 5	23	11-01	3.06	11-06	3 06	8.94	12 00	36.91	8.94	9.00	18.80	122.5	390.7
4 U	20	4-32½	4-32	4.54	453	99.8	459	135	137	20.5	20.2			22	3.03	13.21	10 18	25.81	5.58	5 50	12.42	99.7	209.9
5 D	40	8-24½	8-24	8.41	838	99.7	834	134	132	22.2	21.7	11-34	3.04	44	2.97	7.14	10.11	25 97	6.26	6.34	13.22	100.2	224.5
6 U	12-10	lost.	5-38½	5.64	443	78 6	504	137	135	23	23			12-13	2 77	10.64	7.87	18.65	4.24	3.96	9.07	78 0	120.0
7 D	38	10-25	10-25½	10.42	843	80.9	813	135	135	22.2	22	12-29	2.56	43	2.31	5 76	8.07	20.31	5.16	4.90	10 45	80.7	143 0
8 U	1-33	3-57½	3-57	3.96	659	166.5	657	132	115	23.7	24.7			1-35	.73	15.15	14.42	64 69	19.10	19.16	35.20	170.0	1015.0
9 D	2-05	4-02	4-02½	4.05	664	164	663	122	100	19.5	19	1-51	.06	2 07	.30	14.82	14 52	61.86	17 40	17.76	34.07	164.3	949.0
10 U	.....	.... .	.....	.....	....	.....	...	...	...	....	....	12-34	.92	.....	....	.....	.....	.....	.....	.....	.....	.....	.....
11 U	2-58	4-28½	4-28½	4.48	757	169	757	130	112	24	23.5			3-00	1 33	13 40	14.73	65.56	18.20	18.00	35.56	169.3	1020.0
12 D	3-12	4-05½	4-05	4.09	....	143	585	127	127	24 2	25.2			14	1.43	14.67	13.24	51.39	12.84	13 00	26.61	145.0	654.5
13 U	23	5-16½	5-16½	5.27	731	138.6	741	138	135	24	25.5	3-20	1.44	26	1 60	11.38	12.98	46.95	11.60	11.57	24.10	139.3	570.0
14 D	35	4-16½	4-16	4.27	558	130.7	561	135	140	44.2	25	3-31	1.71	37	1.70	14.05	12.35	40.26	10.37	10.47	21.15	130.7	468.5
15 U	48	5-54½	5-54	5.91	742½	125.7	741	135	137	24.2	24	3-44	1.71	51	1.81	10.15	11.96	35.91	9.40	9.37	18.97	126.8	408.1

Explanation of Table.

Watch "A" given as read, watch "B" corrected as rated by chronometer.

Col. 12 is the mean time of day between start of one run and finish of next.

Col. 13 is found as follows: Tide in miles per hour $= \frac{\text{length of course in feet}}{88} \times \frac{\text{Revs. against—Revs. with}}{(\text{Revs. against} \times \text{time with}) + (\text{Revs. with} \times \text{time against})}$

Tide in Col. 15 is taken from tide curve drawn from figures in Col. 13.

Col. 16 $= \frac{60}{\text{Col. } 4}$. Col. 17 = Col. 16 $\pm$ Col. 15. Col. 21 = .2665 × Col. 18 + $\frac{\text{Col. } 19 + \text{col. } 20}{2}$. Col. 23 = Col. 21 × .1696 × Col. 22.

Col. 22 = average R.P.M. for indicator cards obtained from the recording counter.

Engine $\frac{22 \times 30 \times 30}{24}$. Piston rods 4¼ in. dia.

EDGEWATER

Progressive trials. One screw astern pushing. April 23, 1902.

Mean measured pitch of screw, 10.19 feet. Vessel docked on April 22 and cleaned. Engine end screw removed. Light wind. Smooth water. Length of course, one statute mile. Mean trial draft, 10 feet 1⅝ inches. Corresponding displacement, 687 tons. Wetted surface, 5,764 square feet.

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THE relation between supply and demand in the field of engineering construction is still in the unsatisfactory condition which we have had previous occasion to note in these columns. The situation is in fact one which merits the careful study not only of all who may be directly concerned in these industrial activities, but of students of economic and industrial problems in general. The iron and steel industries collectively, and all manufacturing industries which depend upon them, are tied up with a situation in which the supply bears a totally inadequate relation to the demand, and the consequence is a most unsatisfactory condition as regards all engineering contracts, especially in relation to questions of price, date of delivery, time penalties, forfeitures, etc. This is true not only in regard to structural steel but pig iron as well, and it will not be exaggeration to say that all such contracts entered into during the past twelve months have suffered more or less severely from lack of material, and in only too many cases have exceeded contract time and have become involved in serious questions of penalties and forfeitures.

A contract is let to build a ship; the builder agrees to deliver at a certain date, with penalty for failure to do so. Material is ordered and promised in adequate time. The delivery is anywhere from one to six months or more behind the promise. The builder is penalized accordingly. Can he protect himself by a like penalty for non-delivery of material? By no means. The steel mills do not have to take orders with penalty clauses. The builder has therefore no manner of protecting himself and so must suffer. If he inquires into the situation he learns that the steel producers have booked their entire output for a year more or less, at a rate of output greater than they can reasonably hope to maintain, and that they are behind on all deliveries. He learns that questions of coal and freight cars also enter in, and that his material may actually be ready but must lie in the stock pile waiting for cars in which to be shipped.

It is much the same with other branches of engineering work. Thus, builders of heavy machinery make no pretence of carrying out their agreements. Investigation will show that the reasons are twofold: that they have booked far more work than they can handle, and that they are experiencing the same general trouble in getting material as noted above. Thus the tool builder pushes the blame back to the foundry where he obtains his iron and steel castings. They in turn push it back to the furnaces which furnish pig and coke, they in turn to the iron mines and coal fields. Thus the blame is shifted from one place to another, while in reality it should be pretty evenly distributed over the entire field.

It is easy of course to say that this is all wrong, but far more difficult to propose any adequate remedy. It would indeed be a skillful physician who could suitably prescribe for the present situation. We shall only note this one point: The present situation would never have arisen if everybody had during the past year observed in their promises strict business honesty, using the term not so much in its more common sense as in opposition to the temptation to promise more than can be performed. If firms learn that they cannot obtain material in less than six months' time, but that they can have it in three months and as much more three months later, the general demand is doubled, quite irrespective of the capacity for supply. With promises in accordance with the capacity for supply the demands would become adjusted all along the line, and a normal condition would prevail. Instead of this we have

had during the past year or more the normal demands of six months crowded into three, those of three months into six weeks, and the present local paralysis in many establishments is the result.

The hope of an improvement in the conditions from a wider prevalence of the kind of honesty referred to above is perhaps utopian, but it is worth something to be able to see at least one of the chief causes of our trouble and to note a means of improvement, even if the likelihood of its adoption may seem to be remote.

The fact is that we are suffering from a phase of industrial prosperity to which we are not quite adjusted. There has been a demand for the products of industrial work far exceeding the available supply both of skilled labor and material, and the consequences we are now reaping. Would not a somewhat stronger infusion of business honesty and candor into the field of industrial operations aid in improving the situation?

WE have begun to write 1903 instead of 1902 and thus call it a new year. In one sense each day is just as truly the beginning of a new twelvemonth, if only we will so consider it. The custom of definite points to mark the change of times and season is, however, founded in wisdom and at such periods it becomes natural to note the progress during the past and the promise for the future. So far as the past year is concerned, there is perhaps no very startling achievement in marine construction to which we may point as of epoch-making importance. There has been progress all along the line, but for the most part in well-known channels and of such a character as only shows in the aggregate and after a long period of accumulation. It would, however, not be far wrong to say that the subject which has received the most attention, as involving elements of change and progress, is that of the application of oil fuel in marine service.

References to this topic and descriptions of working systems have appeared in our columns throughout the year, and especially in the December number. A study of these articles for the year would show impressively how much has been done and how live the interest in this topic is. Regarding the steam boiler as a means for generating steam, it is perhaps too much to claim that any notable advance has been made in this direction. The water-tube boiler is still to the fore and retains its hold on the naval services of the world, but it can be hardly claimed that it has made any special advance in the mercantile field.

The steam engine as a means of developing power is still our reliance and seems likely to remain so for some time to come, though in small craft the gas engine in various types has won an assured place, and one which is likely to grow in extent and importance, while the steam turbine has certainly entered the field to remain and presents claims which cannot be ignored. The propeller still remains our instrument of propulsion and it does not seem likely that it will be superseded, nor does it seem possible that any very notable improvement in it can be made.

So far as the year 1903 is concerned, it seems not unsafe to predict a growing interest in the use of oil fuel and a corresponding extension in its use. The water-tube boiler will perhaps make some small advances in the mercantile field, but the fire-tube boiler of the Scotch type will still remain the chief reliance. Increased attention is likely to be given to the mechanical perfection of the steam engine in the way of balance of inertia forces, etc., while the gas engine is likely to appear in increasing sizes and with a growing hold on the field which it has already so largely made its own. There seems no reason why 1903 should not witness the same gradual advance along the entire front as in 1902. On the other hand, it is hard to see from what direction to expect any startling or epoch-making improvements. Such, however, do not always herald their approach, and the advancing days can alone determine whether the coming year is to be thus signalized in the history of the art of marine construction.

AMONG the papers presented at the last meeting of the Society of Naval Architects and Marine Engineers was one on the progressive trials of the screw ferryboat *Edgewater*, a reprint of which will be found elsewhere in this issue. We wish especially to commend here the spirit which prompts the undertaking of such tests, and still more, when once taken, the giving of the data freely for the benefit of the profession at large. Only too seldom are those who are in control of such matters willing to devote the time and money required for a comprehensive test, and still more rarely are they willing to give out the result for the benefit of others. If, however, it is safe to assume that individuals profit most as the entire aggregate moves forward, each sharing in the progress of all, then such contributions to the progress of the body of marine construction as a whole are both generous and wise. It is earnestly hoped that more reports of a similar character will follow.

PRACTICAL POINTS IN SHIPBUILDING.—III.

BY EADS JOHNSON.

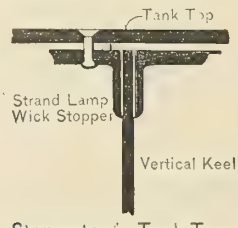
Stopwaters.

The term stopwater, as applied in a shipyard, is taken to mean any device whereby iron-work is made water-tight by any method other than iron calking. It often happens that parts of a ship are entirely inaccessible to the calker and his hammer, and then other means must be taken to make the parts water-tight. To accomplish this result, experience and ingenuity have done much in evolving the present forms of stopwater, and what follows is in a great measure the best results of long experience in this work.

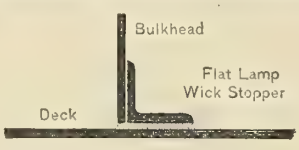
In water-tight work, when it is impossible to calk iron to iron, some filling substance must be placed between the two surfaces in order that they may be made water-tight. The best materials for this work have been found to be tar felt, flat-woven lampwick, strand lampwick, tar paper, white and red lead putty. It is necessary to treat the felt and lampwick some time before using them. For obtaining the best results from tar felt, smear it carefully with white or red lead paint of about the consistency of molasses. This will preserve the surface of the iron, and will have a tendency, when riveted up and set, of filling up any irregularities in the iron-work, and thus make a solid and secure job. Strand lampwick should be dipped in white or red lead paint of about the same consistency as above stated, before stretching in place, and when this sets it will form a perfect barrier to any water which might otherwise filter between the surfaces. Flat-woven lampwick should be thoroughly soaked in linseed oil for about twenty-four hours before being used; or, better, it can be kept indefinitely in a can or receptacle provided for this purpose alone, and then taken in quantities as wanted. When about to put the lampwick in place, smear it thoroughly with red-lead putty on both sides. The oil will keep the wick soft and pliable for an indefinite period, and, as it often happens that work will stand for some time before being riveted, this very quality of pliability is most essential. If the wick has been smeared with red-lead putty without having been soaked in oil, it very rapidly becomes as hard as wood, so that when the work is to be riveted the packing has such a resistance that it is impossible for the rivets to draw the two surfaces of the work tightly together. In consequence, there are numberless small avenues presented for water to find its way through the work, making this condition even worse than if no stopwater had been used.

Tar paper has been used successfully on light decks and bulkheads; it is very thin, and practically offers no resistance whatever when the two surfaces are riveted together. Red or white lead as a stopwater can be either spread thickly on the surfaces before the work is put together, or else forced in place after the work is riveted up, by means of an injector or putty gun, as it is commonly called. A glance at the drawing will show how much pressure may be applied to the lead by this simple device. The red lead from this machine has been known to travel as far as fifty feet along a protective deck, and in some cases, when used in the seams of shell plating, it has burst the rivets.

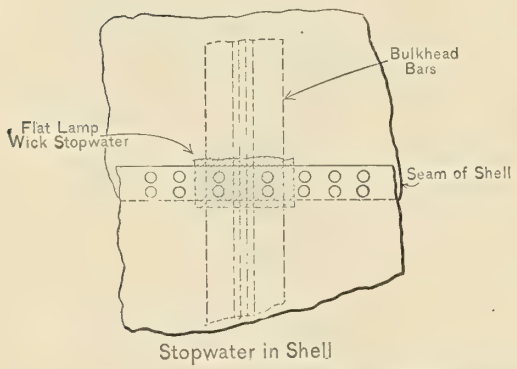
Tar felt should be used under staples, bitts, chocks, or any work requiring very wide materials. Flat-woven lampwick should be used under bulkhead bounding bars; margin lugs or inner bottom margin plates; the seams of the shell or deck plating where they cross a water-tight bulkhead, as this prevents the water entering the seams and traveling across the bulkhead; under angles of engine or boiler foundations on ships with inner bottom; or, in fact, any double bars where there is



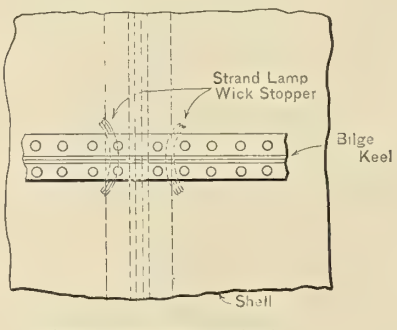
Stopwater in Tank Tops



Stopwater in Bulkhead



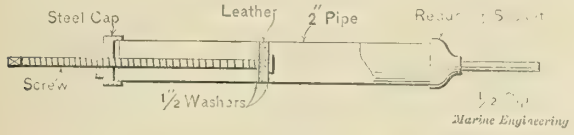
Stopwater in Shell



Stopwater in Bilge Keel

DIFFERENT FORMS AND APPLICATIONS OF STOPWATERS.

no possibility of calking the heels. The lampwick or tar felt can be securely bedded down first, and the holes corresponding to the plating punched through it with a red-hot bar sharpened at one end. Strand lamp-



RED LEAD INJECTOR OR PUTTY GUN.

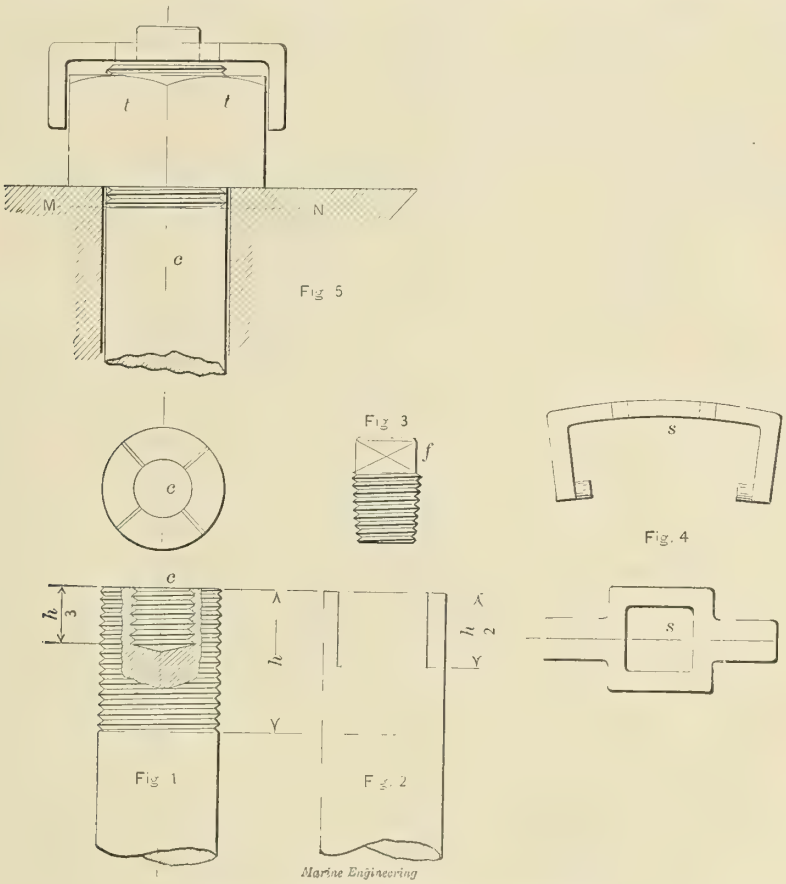
wick is of particular value when placed under the center tank top plate in inner-bottom ships on the calking side of the vertical keel, between the rivets and the heel of the bar. This prevents the water coming from the other side of the vertical keel into the calking side. It should also be placed in bilge keels and fenders where they cross a water-tight bulkhead, as the water can enter the heads of the rivets on one side, travel along the keel or fender, and come out on the other side of the bulkhead. For the same reason it is put under heavy protective deck plates where the plate covers a water-tight bulkhead.

Red or white lead is valuable in all places where the surfaces of the metals are so irregular as to form pockets or avenues for the water to find its way through. Red lead, when forced or pumped in by the injector, fills up all the spaces perfectly and makes a perfectly solid job. In conclusion, it might not be amiss to state that a stopwater should be used more in the character of making a virtue of a necessity. That is to say, it should never be used where calking can be done. There is more poor work done by the injudicious use of felt and lampwick than should be, which has caused much unwarranted prejudice in the minds of many who take but a superficial view of the matter.

New Locking Arrangement for Nuts.

BY N. AKIMOFF.

In most forms of lock nuts, locking is secured by the friction between the screw thread and the surface of the nut, and, in order to have this friction sufficient, the cap must be set up very tightly. Then the strains to be considered are not only the tension and shearing, but also the torsion of the bolt, which may be found by St. Venant's formula. If the strain acting along the bolt is P, it is necessary to design the bolt for strain P_1, which equals 1.65 P.



DETAILS OF NUT WITH LOCKING ARRANGEMENT.

Other considerations than the above make it necessary to use a very low working stress—say from 3,000 to 4,200 pounds per square inch for marine-engine connecting rod ends. Therefore, these bolts are always excessively heavy, and unreasonably increase the dimensions.

The purpose of this note is to call attention to an arrangement in which excessive tightening up of the nut becomes unnecessary, and the bolt will be subjected only to the strain P instead of P_1.

In the accompanying sketch will be found details of the plan submitted. Drill and tap a hole, *c*, in the top of the bolt; the diameter of the hole will be, say, $\frac{d}{2}$, the depth about $\frac{h}{3}$; make four splits with a fine saw to the depth $\frac{h}{2}$, Fig. 2. If the thread of the bolt is right hand, the hole *c* is left-hand tapped. A steel screw, Fig. 3, is made somewhat beveled and tapped with the same thread as the drilled hole. When tightening up in the hole *c*, this screw will increase the friction in the top of the nut, and unscrewing will be absolutely impossible, as the pressure at the top of the thread may be easily made as tight as necessary. An additional locking device is found in the small spring *s*, Fig. 4, which is of somewhat peculiar shape. In each side of the nut is drilled a hole, *t*, about 1-4 inch deep.

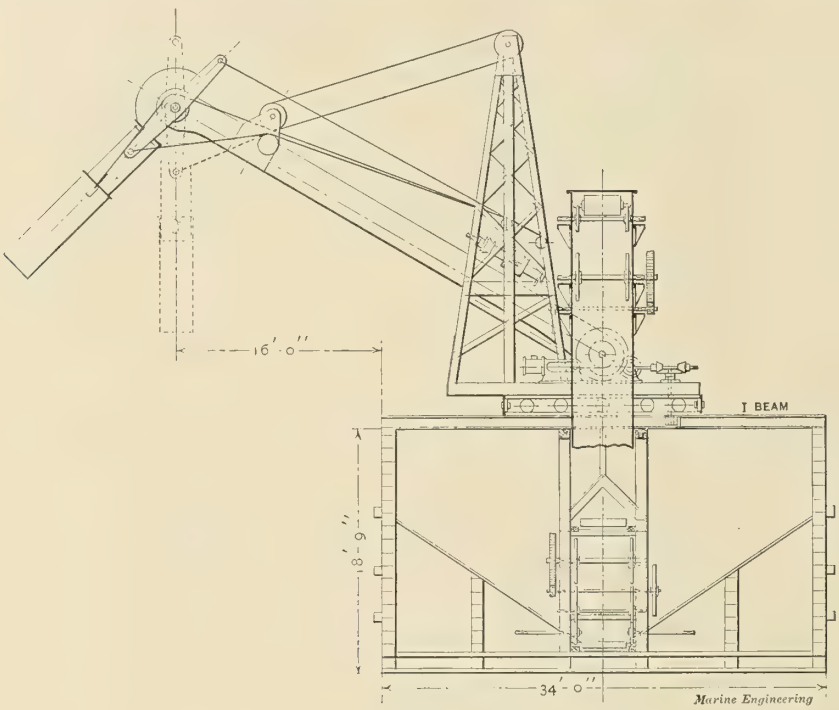
The setting up of these parts may be clearly understood in the general view of the lock shown in Fig. 5. It is evident that it is impossible either to unscrew the nut or the screw, as the threads of one are made opposite the other. It is unnecessary to screw the top very tight, and it is easy to find the proper position where the spring will fit in the drilled holes *t*. As for shearing of the threads, all the tensions remain exactly the same as in the nuts formerly used, and the dangerous section of tension is *MN*.

Steamer Siberia.—The second of the sister ships built for the Pacific Mail Steamship Company at Newport News, Va., the *Siberia*, recently sailed from New York via the Straits of Magellan for San Francisco, where she will be placed in the transpacific service.

Self-Propelled Fueling Steamer.

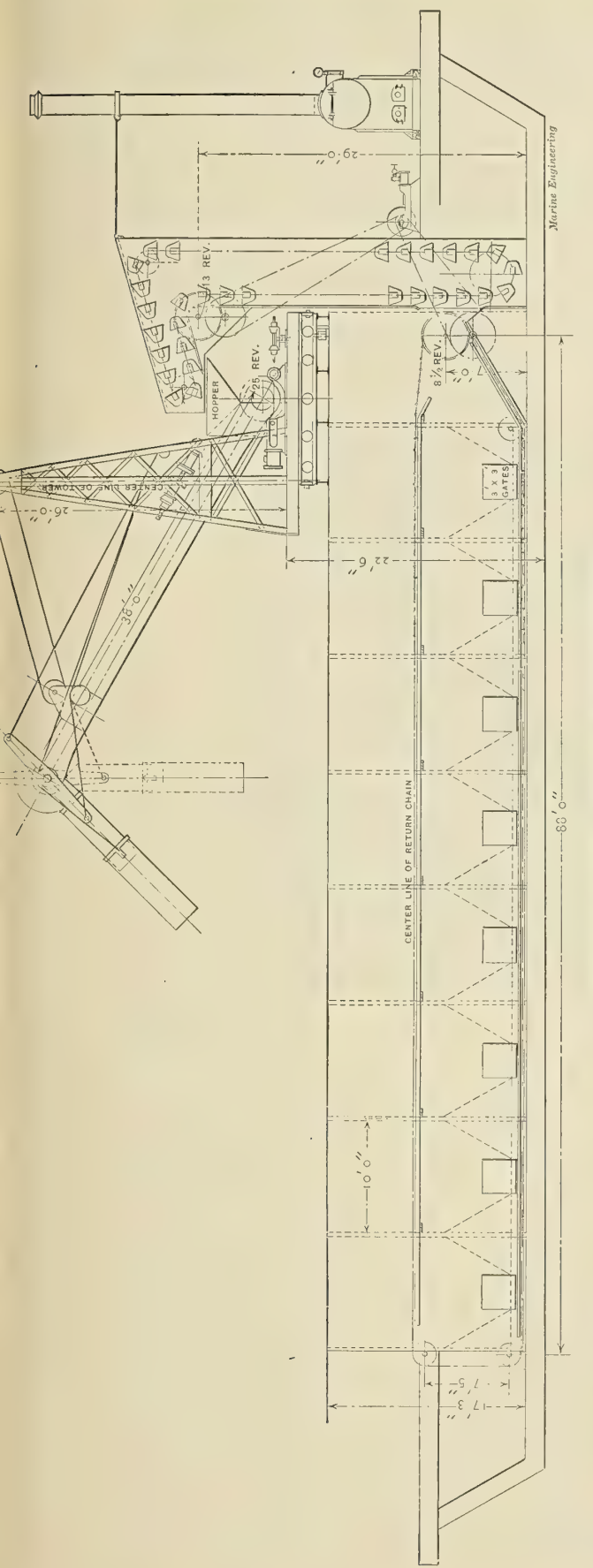
There has been recently built by C. O. Bartlett and Snow Company, of Cleveland, for the Pittsburg Coal Company of that city, the machinery for a self-propelled twin-screw fueling steamer, the general construction and operation of which is as follows:

The steamer is 165 feet long, 25 feet beam, 8 feet depth of hold, being large enough to carry 750 tons of coal aside from her machinery. The main body of the vessel is provided with hoppers which take up nearly the entire length, and are arranged in two rows, one on each side. Along the center line, at the bottom, is a tunnel which extends the length of the pockets and carries the conveyor. The conveyor consists of two strands of heavy chain, to which are fastened flights. Each hopper is provided with an outlet into the tunnel of about 3 feet square, and as the coal falls into the conveyor it is carried by the flights to the end of the vessel, up a short incline, and delivered to an elevator.



CROSS SECTIONAL ELEVATION OF FUELING STEAMER.

The main body of this elevator consists of sheet-iron plates, to which angles are fastened, forming the guides for the chain. There are also two strands of heavy chain, to which are fastened the buckets, centrally hung. These take the coal as it leaves the conveyor, elevate it, and deliver it into a centrally located hopper, mounted on a turntable. Immediately under this hopper is the lower end of an inclined elevator. This elevator is so arranged that the outer end can be raised or lowered so that it will deliver coal to the vessels to be fueled at any angle from the horizontal to 45 degrees. To this end is attached a telescope spout, so arranged that it may be swung out or in to accommodate itself to the hatch of the boat which is being loaded, and also raised and lowered as desired.



LONGITUDINAL SECTIONAL ELEVATION OF FUELING STEAMER.

The motive power for this inclined elevator is derived from a double-cylinder engine of sufficient capacity, located on top of the turntable. This engine also operates the telescope spout and furnishes power for revolving the turntable, by means of which the inclined elevator can be turned to fuel the boats on either side. There is also provided a double-cylinder engine, which is mounted on the deck of the steamer, for operating the conveyor and elevator. Both engines are supplied from a boiler of 150 horse power, placed on deck.

The propelling machinery consists of two 13 by 15 inch non-condensing engines driving 5-foot wheels.

A German View of American Technical Training.

Dr. Vosberg-Rekow, a German expert, has recently visited the United States and examined into the system of industrial educational progress. In an article recently published by him in a German paper, he comments upon the subject of education as follows:

"German industrial advancement is due principally to the thoroughness of our technical education. It is strengthened by the continual introduction of machinery and machine-made tools for hand labor. It is worthy of note that in this evolution, too, the United States has the foremost place and has made gigantic strides not only in applying machine tools, but in inventing and manufacturing them, so that to-day she supplies us.

"This signalizes in an extraordinary degree the keenness of American intelligence. Thus, Americans, though wanting our supplementary technical education, thanks to their practical eye, improve upon our methods and apparatus. Theirs is rather the activity of the experimentalist than that of the plain craftsman; but a clever faiseur, if he but have assurance and luck, may distance his educated master. The Americans have no thorough education, nor do they possess a modern industrial system as we Europeans understand those terms. The American applies himself to a single branch or specialty, with utter disregard of European methods and their results; he devotes to his work an amount of energy which simply stupefies Europe, and for a while he succeeds in driving us out of the line of articles on which he has centered his energies."

Washington Experimental Tank.—In his annual report, Admiral Bowles, Chief Constructor of the Navy, pays a high tribute to the utility of the experimental tank at Washington and cites cases to show that this tank has been of great value to the Department. Some torpedo-boat destroyers, built to the design of the Navy Department, did not attain the required speed, and the builders blamed the lines of the hull and estimated that the alterations necessary would cost about $35,000. Experiment, however, in the tank proved that in some cases the propellers were at fault, and in others that trivial alterations in the hull, costing only $2,500, would insure the required speed. As a result of model experiments, too, a cruiser of 14,500 tons displacement has been laid down which requires less horse power for a speed of 22 knots than a cruiser of another class running at the same speed but only displacing 13,680 tons; while the new 16,000-ton battleships will run at a speed of 18 knots with less power than similar vessels of 1,000 tons less displacement.

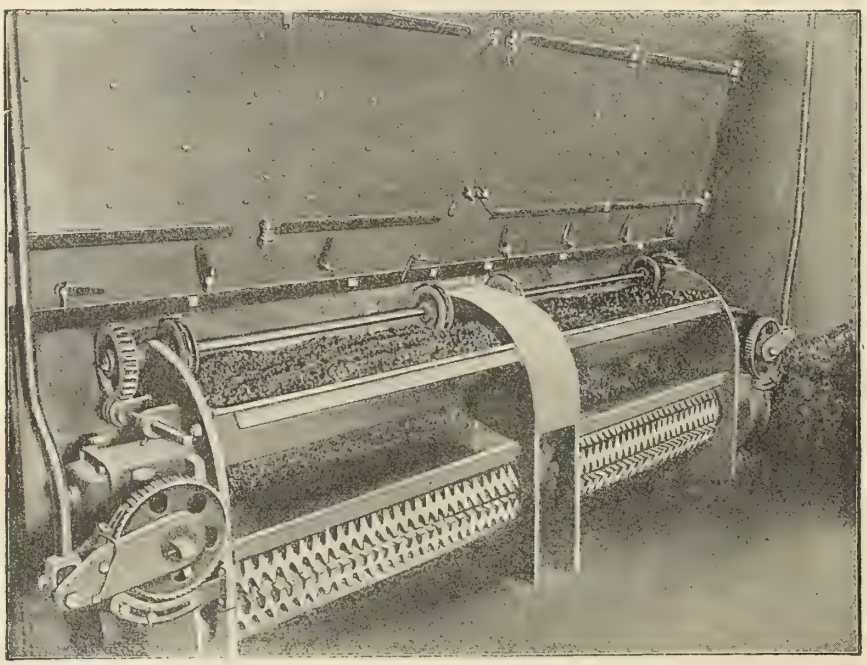
ENGINEERING SPECIALTIES.

The Duluth Stoker.

The stoker here illustrated and made by the Duluth Stoker Company, Duluth, Minn., consists of an endless belt of grate bars; the bars lie crosswise in the furnace, parallel to each other, and are carried by two endless chains, one on each side of the furnace. In front of the furnace the chains pass over sprockets, from which they receive their motion, and at the back of the stoker they pass over sheaves which are keyed to the shaft which is carried by dust-proof bearings at either end. To each of these bearings is attached an adjusting screw to give the proper tension upon the chains which carry the grate bars.

Both the top and bottom members of this chain of grate bars are supported by rollers or fairleaders. The motion of a top member is from the front of the furnace toward the back, and in the front and above the grate bars is placed a hopper for receiving the coal. The motion of the grate bars under the hopper carries in a film or layer of coal upon the bars, whose thickness is determined by a regulating plate which extends the whole width of the stoker and is adjustable for height, so that the thickness of the fire may be regulated to suit the demands for steam. At the back end of the stoker is placed a forged steel water box in the water circulation of the boiler, which serves the purpose of preventing the good fire from falling over the back end with the ashes and clinker. This end is adjustable for height, so that the space between grate bars and cross box can be regulated to suit the different size of clinker formed when various kinds of coal are being burned. Its action is as follows: The ashes and clinker pass underneath the cross box, following the motion of the grate bars, while the unconsumed carbon lying on top is held back by the lower edge of the box, effectually closing up this opening and keeping the back end of the furnace covered with good fire. The loss of coal down through the grate bars is prevented by placing underneath the bottom member a plate, which catches the fine coal sifting through the grate bars.

The grate bars each have two wrought-iron lugs or hooks on their lower edge, which hook into the links of the chains, alternate bars hooking in from opposite sides. The upper faces of the bars are toothed and lock into each other, leaving sufficient opening between them to admit the proper quantities of air to the fire. It is only possible to remove these grate bars while they are passing over the front sprockets. The sprockets on the front shaft of the stoker, which drive the chains, are operated by a single worm and worm wheel, the worm being driven by ratchet connected to eccentric rod, the eccentric being carried on the line shaft placed above the stoker.



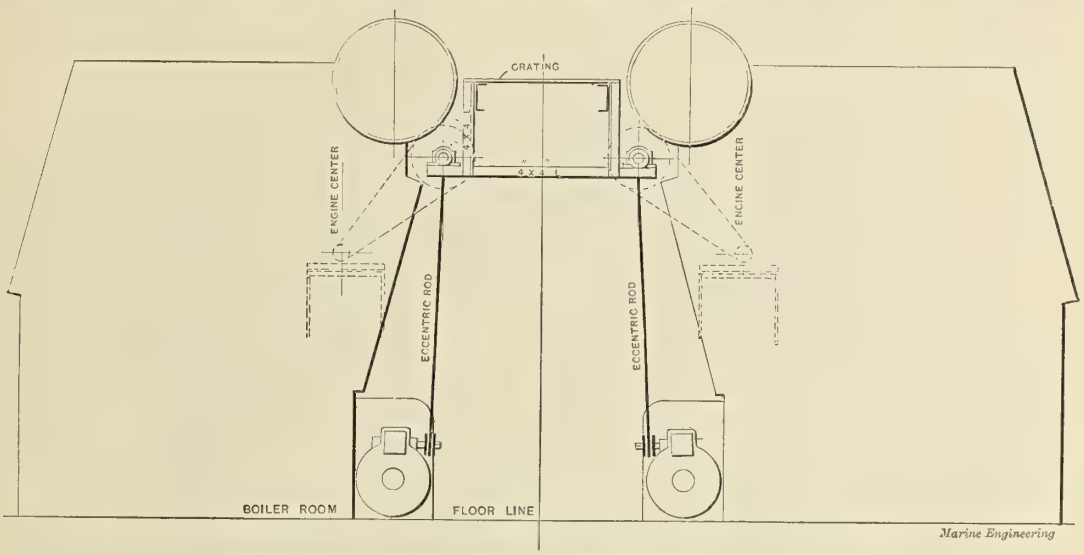
THE DULUTH STOKER FITTED TO MARINE BOILER.

The marine boilers to which these stokers have usually been applied are of the Babcock and Wilcox water-tube type, placed athwartship with their fronts facing each other, and have two stokers installed under each boiler. Two line shafts, extending along the front of each set of boilers and run by separate engines, drive the stokers, as shown in the accompanying sketch. The engines are bracketed on the engine-room side of the bulkhead and so are under the care of the engineer. A cross drive is provided between the two line shafts, so that the whole stoker plant, in case of necessity, could be driven by one or the other engine.

These stokers are producing at all times smokeless combustion with a cheap grade of slack coal, and their economy is due, in part, to the fact that the heating surfaces are kept free from a soot deposit, rendering them capable of readily absorbing the intense heat generated by the stoker fire. The operation of stoking

consists simply in supplying the hoppers with coal and removing the ashes from the rear of the boilers; and as fires require no poking, slicing, or other agitation, and as there are no fire doors to be opened, admitting cold air to the furnaces, it is evident that economy is sure to result from their use.

The body of the Duluth stoker is composed almost entirely of structural steel, and the very best material and workmanship are employed throughout its entire construction. The driving gear is enclosed in oil-tight and dust-proof casing, insuring easy working and freedom from destructive wear. The ratchet which drives the worm shaft is supplied with a regulating device, by which the stoker can be stopped instantly without stopping either the engine or line shaft, the same adjustment also permitting of five changes in speed, so that with adequate means to regulate the thickness of the fire upon the grates, and also the speed of the grate bars, it is possible to meet all requirements for steam.



ARRANGEMENT OF DRIVING SHAFTS FOR DULUTH STOKER, LOOKING FORWARD.

Direct-Connected Engines.

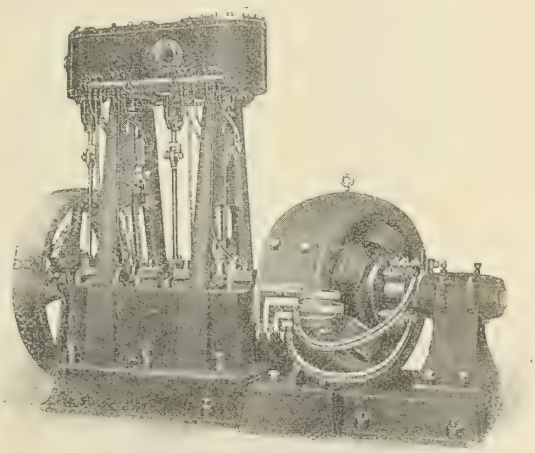
The John E. Thropp and Sons Company, builders of marine and stationary engines and boilers, of Trenton, N. J., has placed on the market a line of high-speed engines for direct connection to electric generators, one of which is herewith illustrated.

Engines of this class where the load varies and the speed is high require the best material and workmanship. The cylinders are supported upon hollow cast-iron housings which are securely bolted to a substantial bed. Each engine is fitted with oil guards, and the bed plates are so constructed that all the waste oil is caught and passes out at the bottom of the plate through a small pipe. The housings and bed plate are bored in the lathe after being babbitted, to guarantee the alignment. The main bearings are of the inserted type.

All the castings are made of best charcoal iron, hard, close, and free from sand holes. The high-pressure valve is of the balanced piston type and the low-pressure valve of the balanced slide type, which overcomes one of the serious objections often encountered in high-speed engines. The crossheads are made of steel, fitted with brass gibs. The crank shaft is made extra large and of forged steel, having large crank pins, which insure a smooth working engine. The connecting rods, eccentric rods, piston rods, and valve stems are also of forged steel, finished entire length.

The cylinders are jacketed with Russia iron and lined with asbestos, and banded top and bottom with either brass bands or strips of Russia iron.

Each engine is fitted with a Detroit sight-feed cylinder lubricator and a large multiple sight-feed oiler completely piped to all moving parts. The body of the oiler is of finished brass and makes an attractive addition to the engine. Each engine is fitted with one Rites inertia governor, guaranteed to regulate within 1 1-2 per cent. between full and no load.



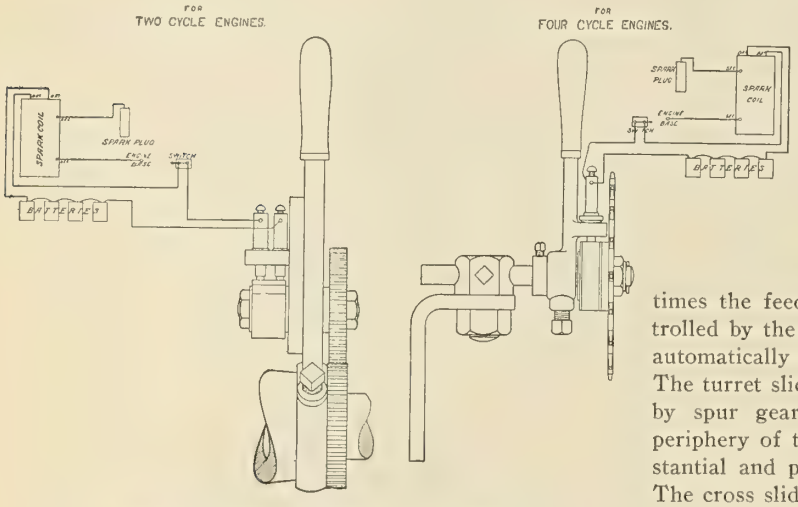
DIRECT-CONNECTED GENERATING SET.

Every engine is fully guaranteed as regards material and construction.

The Detroit Igniter.

This igniter may be put on any engine of one or more cylinders by the user of the engine.

The cause of most troubles with gas engines is the igniter. The tube igniter frequently requires new tubes. When one gets a little old, the engine will miss explosions and fire the expelled charge in the exhaust pipe. Considerable fuel is used to heat the tube and ten to fifteen minutes are required to start. It is also unsafe to have a flame in a closed room where there is apt to be gasoline exposed to the air.



IGNITER FOR TWO- AND FOUR-CYCLE GAS ENGINES.

The touch spark electric igniter has, of course, a moving electrode through the cylinder walls. The burnt gas and intense heat cause this igniter to stick, corrode, and give trouble, while the points become covered with deposits from the gas and finally refuse to make a spark, and in most engines it is necessary to break a packing joint to remove the electrode for cleaning. A wipe spark igniter is subject to frequent breakage and rapid wear, which soon interferes with the proper point of ignition, while with any ordinary igniter there is little or no provision for changing the point of ignition for starting the engine—a feature of great importance and much desired by all users of marine and stationary engines.

With this igniter to start the engine the commutator handle is readily shifted, and after the engine is started the lever is placed so as to secure any point of ignition desired.

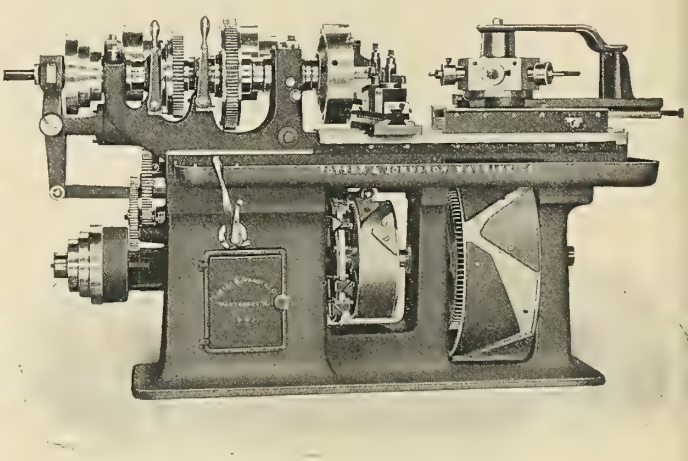
With this igniter no moving parts are on the inside of the cylinder, therefore there is nothing to become gummed up and stick. The sparking plug screws through the cylinder wall into the combustion space, so that it can be removed in a moment's time if necessary to inspect or clean. The spark jumps between the intervening points at the end of the plug, these points being about 1-32 inch apart.

In the case of four-cycle engines, should it be desired to make a spark only as often as the charge is drawn into cylinder, this device may be furnished in such form as to accomplish this purpose.

Further information may be obtained from the Detroit Motor Works, Detroit, Mich.

Automatic Chucking and Turning Machine.

The cut shown herewith represents the latest improved automatic chucking and turning machine, which has recently been placed upon the market by the Potter and Johnston Machine Company, Pawtucket, R. I. The machine is arranged for the automatic production of all kinds of castings up to 10 inches diameter and 6 inches long. It possesses several new and very valuable features heretofore unknown to this particular class of machinery. The turret has five sides, with 2 1-2 inch holes, and it withdraws, revolves, and advances at forty times the feeding speed. The feed is driven and controlled by the spindle. The cross slide can be operated automatically at any time in conjunction with the turret. The turret slide is operated by a large cam drum driven by spur gearing, the power being applied near the periphery of the drum. This arrangement is very substantial and prevents any spring of the working parts. The cross slide tool blocks have a travel of 4 1-2 inches in each direction, and have screw adjustment on cross slide. The standard set of cams furnished with the machine covers all ordinary pieces up to 6 inches long and requires no adjustment.



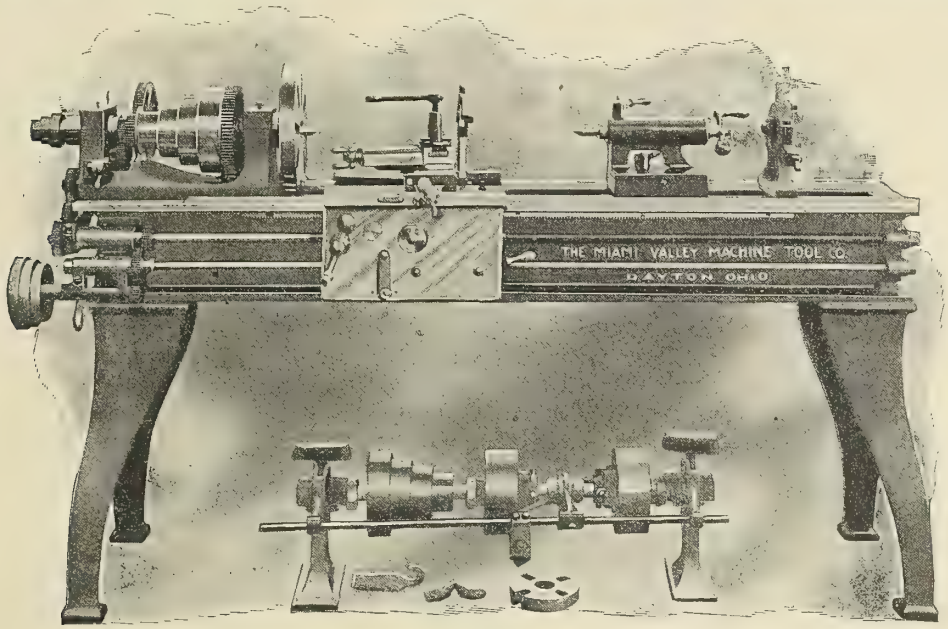
AUTOMATIC CHUCKING AND TURNING MACHINE.

The automatic back-facing attachment shown in cut is a very valuable addition to the machine. This attachment enables the hubs of gears, pulleys, etc., to be finished on both ends at one setting, and in this manner a large variety of pieces which would ordinarily require to be done in two holdings can be finished complete at one setting. Another very interesting feature in connection with the machine is the automatic chuck. By the use of this chuck pieces which can be handled with

one hand can be placed into the same and removed without stopping the spindle; thus the machine is running all the time, and requires very little attention from the operator, hence he can readily run from four to eight machines, according to the class of work being done, making the labor cost of production a very small item in comparison with the increased product obtained.

For gripping extra heavy or eccentrically-shaped pieces, a heavy scroll chuck is furnished with the machine. A pair of universal turning and facing tools is furnished as part of the standard outfit of the machine, and takes care of all ordinary pieces up to 10 inches diameter. The machine is made in three types, viz.: with geared automatic change speed head, with belt-driven change speed head, with plain head. The machine has plenty of power, strength, and rigidity; all working parts are simple and easy of access.

Although this new designed tool has been on the market but a comparatively short time, it has been favorably received by the trade, and is used in a number of shops, including the following lines: Textile, woodworking, pumping, power transmitting, electrical and paper making machinery; printing presses, punches, presses, pneumatic tools and air brakes, etc.



A NEW LATHE.

New 13 1-2-Inch Lathe.

A new 13 1-2-inch lathe is shown in the illustration, made by the Miami Valley Machine Tool Company, Dayton, O. No novel features have been introduced in the design, the main considerations having been to produce a lathe with parts of ample proportions, convenient to operate, and durable and accurate in construction. The spindle is of high-grade steel, with ground journals and phosphor-bronze boxes. The cross feed is graduated. The chasing stop is always with the lathe, and it is impossible to throw in rod and screw feeds at the same time. The feed cone is provided with a swinging tightener. The centers are large, with no bushing in the spindle, but a safety plug is provided to avoid accident when the center is removed. The tailstock is of the overhanging style, with set-over. The feeds in head and apron are reversible. The head and tail stocks are fitted to the bed with a V at the rear and flat bearing in front, permitting the cross-bridge of carriage to be heavy and rigid. Besides the belt and rod feed, a positive feed can be obtained by engaging gear on lead screw to the feed rod. The carriage is provided with lock screw. It has V bearing in front and flat bearing in rear, and is gibbed. All sliding bearings on the V's are fitted to completely cover them and avoid wearing a ridge in them. The power cross feed is thrown in and out by moving a button. The countershaft has double friction pulleys, simple in construction and easy of adjustment. Care has been taken to insure perfect facilities for oiling all bearings, especially in the apron. The compound rest is graduated in degrees.

The feed belt has swing tightener, the test limit on the spindle is .001 inch.

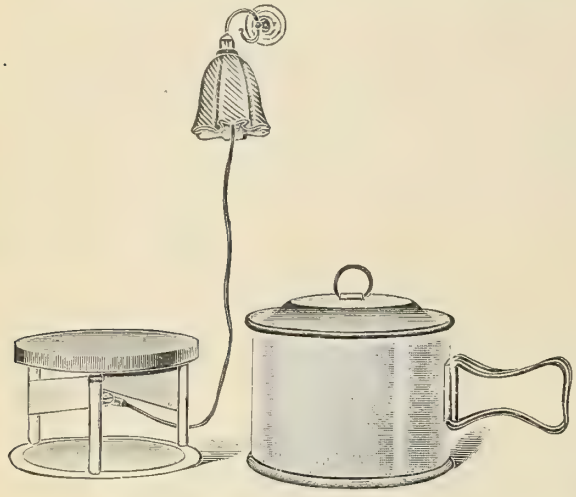
The front bearing of the spindle is 2 inches diameter, 3 3-4 inches long; the rear bearing of spindle, 1 5-8 inches diameter and 3 inches long; and the hole through the spindle, 1 1-16 inch. The diameters of the head cone pulley are 3 1-2, 5, 6 1-2, and 8 inches, and the ratio of the back gearing is 9.1 to 1. The lathe cuts threads 4 to 64, including 11 1-2.

Travelers' Electric Stove.

The outfit illustrated on the next page meets a very pressing demand for an electric heater equally as useful at home as when traveling. The bottom is recessed, so that the cup encloses the heater when set upon it and locks in place. The heater is oxidized steel and the frame white enamel. It has 6 feet of conductor cord and a lamp socket plug with an adapter, so it may be connected to either Edison or "T. H." sockets. An as-

bestos table pad permits its use on a polished table without injury from heat.

The cup has a capacity of three half pints; is heavily tinned inside; polished nickel outside. All parts pack



ELECTRIC STOVE FOR TRAVELERS' USE.

within the cup, which is 3 1-4 by 5 inches, and weighs complete two and a half pounds packed. The manufacturer, the Simplex Electric Heating Company, Cambridgeport, Mass., has made and sold thousands of electric heaters the same size but of less portable form. The heaters are made from 110 to 250 volts current.

Wreck of the Steamer Delano.

Editor MARINE ENGINEERING:

Another ship has been added to the long list of marine victims that have left their bones on the rock-bound shores of Newfoundland in the neighborhood of Cape Race. This time it is the steamer *Delano,* which was on a voyage from Rotterdam to Baltimore, via Sunderland, where she coaled.

The vessel struck at a place called Seal Rocks, near the fishery town of Reneives and about twenty miles north of Cape Race. She went on shore at 8 o'clock in the morning, during a fog so dense that the ship could not be seen her entire length. Fortunately, the weather was calm and the water comparatively smooth at the time, otherwise all on board might have been lost. As it was, the boats were got out without any difficulty, and the crew landed in safety. The captain and officers remained on board until next day, when Lloyds' agents arrived. After the latter examined the ship they found a number of holes in her bottom, and, deciding that she was beyond getting off, she was condemned and sold. All the provisions, clothing, furniture, and loose gear have been saved.

In accordance with marine regulations, the captain was examined by the board in connection with the loss of the ship. After the strictest and most minute inquiry, the board exonerated him from all blame, inasmuch as he had taken all human precaution in navigating the ship during the fog. His log shows that he should have been thirty miles from land when the vessel struck, and his position was entirely due to a strong northwardly tide, which threw all his calculations out, The steamer went ashore near where the *Scottish King* was lost two years ago.

Every steamer that approaches the neighborhood of Cape Race in foggy weather makes a certain allowance for tide, and generally this allowance brings the ship clear. But at certain periods, which no experience can define, an extraordinary tide sets in and defies the skill of the best navigator on the Atlantic. The present Minister of Marine in this country (Mr. Murphy) is deeply interested in the tidal vagaries of Cape Race and neighborhood, and he has recently had a map prepared, on which the location and name of every wreck for half a century is placed. M. A. D.

THE STEAMER DELANO ON SHORE.

Torpedo-Boat Destroyer Lawrence.

On the official standardization trial the torpedo-boat destroyer *Lawrence,* built at the works of the Fore River Ship and Engine Company, Quincy, Mass., made a record of 29.4 knots. The trial was held over a measured mile off Provincetown, in Massachusetts Bay, and was in charge of the Official Trial Board. Following is a summary of the results of the standardization trial:

Run.	Time.	Mean revolutions.	Rate of speed.
1 south	2.384	749.5	22.727
2 north	2.332	732.5	23.499
3 south	2.202	757.5	25.678
4 north	2.180	735.5	26.087
5 south	2.120	750.0	27.273
6 north	2.130	750.0	27.068
7 north	2.098	752.5	27.735
8 south	2.038	738.0	29.079

The auxiliary steam pipe in the after engine room burst just as the *Lawrence* was making her sixth run over the course, and prevented her from being turned in order to make the distance in the opposite direction, as she had previously done. The difficulty was soon remedied, but it had reduced her speed sufficiently to make a perceptible difference in the figures, but the record on the run was 29.4 by the official record.

The load-water-line length of the *Lawrence* is 240 feet 10 inches; length over all, 246 feet 3 inches; extreme breadth, 22 feet 3 inches; mean draft, 6 feet 3 inches; depth from deck to keel, 14 feet; displacement, 400 tons; and full-load displacement, 514 tons. Coal bunkers stand on either side for a length of 100 feet amidships and have a capacity of 147 tons, which, it is calcu-

lated, will give the vessel a steaming radius of 3,000 miles at 14 knots or 1,000 at 30 knots.

The *Lawrence* has twin screws and vertical, inverted, direct-acting, four-cylinder, triple-expansion engines.

TORPEDO-BOAT DESTROYER LAWRENCE.

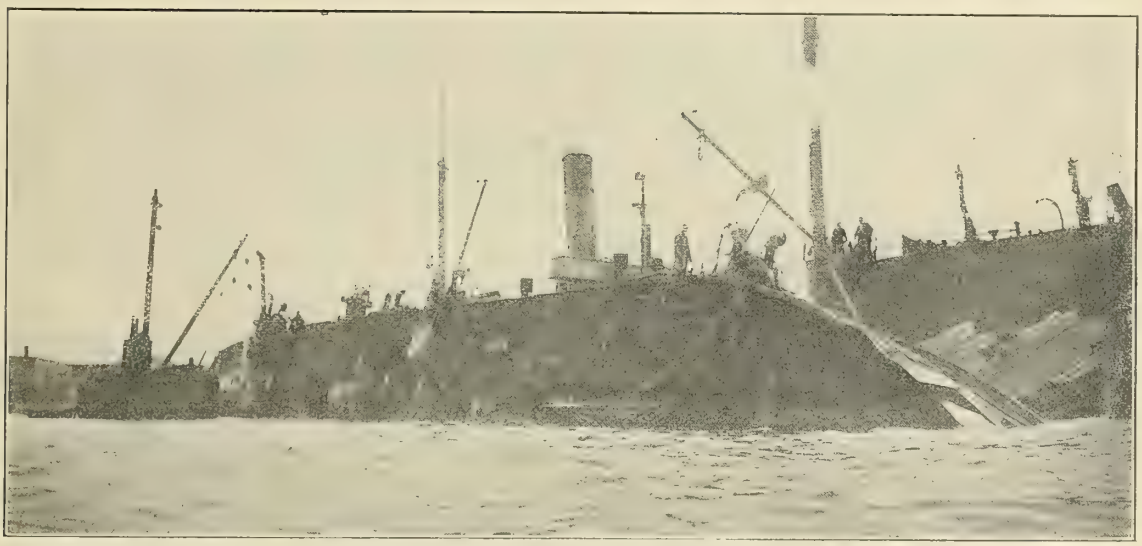
The high-pressure cylinder is 22 inches, the intermediate 31 inches, and the two low-pressure cylinders 34 inches in diameter, and the stroke is 20 inches. The main engines are in two separate compartments amidships, the starboard engine being placed forward of the port engine, and at 360 revolutions, with steam at 240 pounds, they are designed to develop 8,400 horse power.

The water-tube boilers were made by the Fore River Company from its own designs, and they are placed, two in the forward and two in the after fire room, the fire rooms being forward of the engine rooms. The grate surface aggregates 315 square feet, and there are 17,768 square feet of heating surface, with two blowing engines for forced draft in each fire room.

The destroyer is designed to carry two torpedo tubes for long 18-inch Whitehead torpedoes, mounted on the fore-and-aft line of the main deck. She will also carry two 3-inch rapid-fire and five 6-pounder rapid-fire rifles. The torpedo tubes are to be carried in water-tight compartments just below the main deck.

Tank Steamer Maverick.

The possible dangers in the transportation of oil in bulk are illustrated in the accompanying view which was taken of the Imperial Oil Company's tank steamer *Maverick*. The *Maverick* was discharging a cargo of oil in Halifax, N. S., when the discharge pipe sprung aleak and allowed the oil to flow down into the hold of



OIL-TANK STEAMER MAVERICK, BEACHED NEAR HALIFAX.

the steamer unnoticed until it reached the furnace door in the boiler room. The oil then ignited, and in order to save the ship she was towed down to Bedford Basin and there beached and scuttled. The following spring the vessel was raised after two unsuccessful attempts; and the photograph was taken when she was finally floated. The ship was then taken to a New England port for repairs and is now running in her usual capacity.

QUERIES AND ANSWERS.

Q. 114.—Will you kindly answer, in your valuable inquiry column, the following question: What is a stopwater, what is it used for, what are the different kinds of stopwaters?

M.

A.—Stopwater is a term which has come down from the days of wooden shipbuilding. It was the name given to a wooden pin or plug driven between the two surfaces of a joint, usually at a corner, and intended to stop off or prevent the water from passing into the joint beyond. Thus a stopwater was often driven into the joint of a keel scarf in order to prevent the water from passing in between the inner surfaces. For a similar reason a stopwater was usually fitted in the joint between the stern post and keel. The term is still occasionally used in reference to any pin or key or similar device for stopping off or preventing water from traveling along a joint or seam. See the article on this subject in this issue.

Q. 118.—Would you give me a rule for finding the horse power of a marine engine, high-pressure cylinder 13 1-2 inches; intermediate, 21 inches; low, 34 inches; stroke, 21 inches; revolutions, 280 per minute; steam, 225 pounds; vacuum, 25?

J. C.

A.—The rule for finding the power from the data given would be the usual horse-power rule, as follows: Multiply the mean effective pressure reduced to the low-pressure piston by the area of the l. p. piston in square inches and by the piston speed in feet per minute, and divide the product by 33,000. The area of the l. p. piston is 908 square inches. The piston speed is $2\times21\times280\div12=980$. The mean effective pressure reduced to the low-pressure piston cannot be found in any such simple manner. It is this factor which would be furnished by indicator cards, if such were at hand. In their absence we must resort to such assumptions as seem reasonable, and compute the probable value in this way. This may be done by the aid of the following formula:

$$p=f\left(p_1\frac{1+\log r}{r}-p_2\right)$$

where p_1=absolute pressure at boiler, p_2=back pressure on exhaust side of low-pressure cylinder, r=expansion ratio, and f=a factor which, for triple-expansion engines, may be taken at about .65. Regarding the value of r we must remember that the total expansion may be considered in two parts, that in the high-pressure cylinder and that between the high-pressure and the low-pressure. The point of cut-off in the high-pressure is not stated, but if it is taken at about .60, and if we take about 15 per cent. clearance, the expansion in the high-pressure cylinder alone will be $(1.00+.15)\div(.60+.15)$ or $1.15\div.75=1.53$. Then the expansion between the high-pressure and the low-pressure will be as the areas, or as the squares of the diameters. This will give a ratio of $(34)^2\div(13.5)^2=1156\div182=6.35$. Hence, the total probable expansion ratio of the steam will be $6.35\times1.53=9.7$. We must next find the natural logarithm of this number, which may most readily be taken from a table, or, if such table is not at hand, we may take the common logarithm and multiply by 2.304. We thus find the natural logarithm of $9.7=2.2721$. We next take for p_1 the absolute pressure at the boiler with proper allowance for drop in steam pipe. The absolute pressure at the boiler will be $225+15=240$, and, allowing 10 pounds drop, we shall have at engine $p_1=230$. For p_2, the back pressure, we will take 3 pounds, corresponding to a pressure slightly above that for 25 inches of vacuum. We may now substitute in our formula and find as follows:

$$p=.65\left[\frac{230\times3.2721}{9.7}-3\right]=48.5$$

Now substituting in the horse-power rule we have

$$\text{I.H.P.}=\frac{48.5\times908\times980}{33{,}000}=1308$$

The result thus obtained is simply an estimate based on what might be expected with steam pressure and revolutions as stated, and with steam ports and passages of size suitable to maintain the pressure without serious loss by wiredrawing.

Q. 119.—Will you please answer the following through your paper: Describe in detail what is now considered the most improved method of testing a new boiler for strength, and in order that the same condition may exist, as nearly as possible, as when the boiler is in actual use, and to avoid undue shock and strain on the boiler.

2. Describe how you would test an old boiler in place on board a ship, with the conveniences usually found on board.

J. S. S.

The test pressure enforced by the United States inspection rules is one and one-half times the working pressure desired. The method of applying the test is by water under pressure, and it is not practicable to realize fully the conditions under which the boilers operate when under steam. If the water can be pumped in regularly and without developing serious fluctuations of pressure, the boiler should receive no harm, and the purposes of the test should be safely and satisfactorily realized.

To prepare a boiler for such test, the springs should be removed from the safety valves and a length of pipe or other rigid strut substituted, so that the valves may be screwed down fast. All stop valves, cocks, gage-glass connections, etc., should then be tightly closed, except such as may serve to admit the water and to register the test pressure employed. While the test is progressing the boiler should be subjected to the most careful examination inside and out. The furnaces, combustion chambers, and back-tube sheets may be examined from the inside, and the shell, with its various joints and seams, from the outside. As small leaks develop they are stopped by calking, if possible, or, if about the tube ends, by re-expanding. Especial watch must be made for any signs of bulging, buckling, or other deformation. When especial care is to be taken gages are provided in the furnaces and combustion chambers and on the shell. These will serve to indicate or to measure the actual amount of distortion resulting from the gradually increasing pressure. If the distortion or bulging at any point should seem to be unusual, the pressure should be relieved by letting off a little water or by stopping the pump and allowing it to escape by leakage, in order to see if any permanent set has been made. In a thoroughly satisfactory test, all gages should return to the original setting when the pressure is finally removed, showing no permanent set at this point. It will not usually be found possible to tighten the various valves so that there will be no leakage, and an idea of the amount of such leakage may be obtained by noting the rapidity with which the pressure-gage pointer moves backward when

the pump is stopped, or by the amount of pumping required to maintain the pressure at its full value. The gage pointer will also indicate, by a more or less sudden movement backward, the development of leaks at any points, should such occur.

The fundamental purpose of the test is twofold: To develop leaks or weakness. If the leaks in the joints are only small and such as may be controlled by calking, and if there is no evidence of undue distortion, and if the gages return to their original setting, the test may be considered as satisfactory in all respects.

In some cases the water test has been carried out by filling the boiler and then lighting wood fires in the furnaces. The expansion of the water will furnish the increase of pressure desired, which may be eased by a valve or cock as necessary. While the boiler in such a case is more nearly in its regular service condition, still the actual steaming conditions are far from being fulfilled, and the furnaces, combustion chambers, and back-tube sheet are not available for examination during the test. The pressure is also under less definite control than by the pump method, and, on the whole, the latter is now usually preferred.

In testing an old boiler on board ship, as nearly as possible the same general routine as above should be carried out. Many of the details would depend on the appliances and means available. The principal trouble might be with the means of getting the pressure. With an auxiliary boiler on board, on which a pressure may be carried somewhat higher than that regularly carried on the main boiler, it may be possible to get the test pressure needed by the feed pump operated from this boiler. If not, then some form of hand-test pump must be provided. The principal difficulty with the latter is that with such leaks as are liable to develop in the joints, seams, and connections, when under the test pressure, it may be difficult with the hand pump to maintain the pressure. It will, at least, however, serve to develop the leaks, and as they are gradually stopped, it will be possible to hold more continually the pressure by the small pump.

Q. 120.—Would you please work out for me the following information: In a cylindrical return tubular boiler 12 feet diameter, pressure 150 pounds, two plain furnaces 40 inches diameter, 6 feet long, made of mild steel with tensile strength of 60,000 pounds to withstand a working pressure of 150 pounds, I would like to know the following particulars:

1. Thickness of shell.
2. Thickness of furnace.
3. Size and spacing of stays.
4. Diameter of rivets.
5. What would be the thickness of corrugated furnace for above boiler? Corrugations being 6 inches pitch, furnace diameter 7 feet 6 inches long.

The factor of safety is to be 4 1-2, the strength of joint 80 per cent. of the plate, and the shell is to be increased 1-16 inch for corrosion. A. F.

A.—The thickness of shell may be determined by the formula,

$$t = \frac{pD}{2T}$$

in which p is the pressure in pounds per square inch, D the diameter in inches, and T the safe working strength. Since the factor of safety is to be 4 1-2 and the strength of joint is estimated at 80 per cent. of the plate, the value of T will be found by taking 80 per cent. of 60,000 and dividing by 4.5. This gives 10,666. We have, therefore, for the thickness of shell

$$t = \frac{150 \times 144}{21333} = 1.01$$

To this we add 1-16 of an inch for corrosion, giving T=1 1-16 inches.

If the furnace is to be entirely plain, that is, without corrugations, Adamson rings, or other similar support, the thickness as given by the United States rule would be as follows:

$$t^2 = \frac{LDp}{89600}$$

in which L=length in feet, D=diameter in inches, and p = pressure. Hence we have:

$$t^2 = \frac{7.5 \times 40 \times 150}{89600} = .5, \text{ or } t = 3\text{-}4 \text{ inch nearly.}$$

This is entirely too thick for such service, and such a type of furnace should never be employed in a boiler of this character. For the corrugated furnace, the thickness by the United States rule would be as follows:

$$t = \frac{Dp}{15000} = \frac{40 \times 150}{15000} = .4 \text{ inch}$$

or say 7-16 inch.

The size and spacing of stays will depend upon the details of the fitting. The combustion chamber plates might be made 1-2 inch thick, with screw stays spaced 7 inches by 7 inches, and 1 1-8 inches diameter at bottom of thread if steel, or 1 1-4 inches if iron. The head stays may be spaced about 15 inches by 15, and should be about 2 1-4 inches diameter at the smallest section. The upper heads may be made either 1 inch thick and without washers or other reinforcements for the stay nuts, or 3-4 of an inch thick with washers fitted in accordance with the United States Rules.

Regarding the riveted joints, the longitudinal shell joints should be double butt-strapped and triple-riveted, with the rivets double-spaced in the outer row on each side. With such a joint, using 1 1-8-inch rivets, the pitch in the outer row would be about 8 inches and in the inner rows about 4 inches. The distance between the middle and inside rows would be about 3 1-2 inches, and that between the middle and outside rows about 4 inches. The circumferential joints should be double-riveted, with a spacing of about 2 3-4 inches in each row.

Regarding various details in connection with the design of such a boiler, you may be referred to the United States Rules prescribed by the Board of Supervising Inspectors of Steam Vessels, a copy of which may be obtained on application to the Treasury Department, Washington, D. C.

Q. 121.—I wish to take up a short course in mechanics and would like to know if you will give me the names of one or two elementary books for study. I am a salesman in a steam specialty house and would like to have some technical information. My time is so much taken up that I cannot devote over six or eight hours a week to study. W. R.

A.—Assuming that you would prefer books on Mechanics which do not require a knowledge of differential and integral calculus, and such books as treat the subject in a plain and simple manner and as far as possible without the use of higher mathematics, a selection among the following may be suggested: Culverwell, E. P., *Elementary Mechanics;* Dana, E. S., *A Text Book of Elementary Mechanics;* Lock, J. B., *Elementary Statics;* Lock, J. B., *Dynamics for Beginners;* Magnus,

Sir Philip, *Lessons in Elementary Mechanics;* Peck, W. G., *Analytical Mechanics;* Alexander, T., *Elementary Applied Mechanics.* Part I. These books are not expensive, averaging only a little over $1 each, and may be obtained from any dealer in technical books, or, if desired, through MARINE ENGINEERING.

TECHNICAL PUBLICATIONS.

Screw Propeller Computer. By G. R. McDermott, Professor of Naval Architecture, Cornell University. A special form of disk slide rule, with leather cover, 7 inches by 7 1-2 inches, with text separately bound, pp. 52, giving a brief discussion of the resistance and propulsion of ships, and directions for the use of the computer. Price $5. Taylor and Carpenter, Ithaca, N. Y.

There is perhaps no problem with which the naval architect or marine engineer is concerned which presents so many difficulties as that involving the intelligent design of a screw propeller to fulfill a given programme of conditions, or the analysis of the performance of a propeller with a view to determining the relative efficiencies of the various component features. This is due chiefly to the intricate manner in which the various items are interrelated, and the difficulty of expressing in any simple formula or manner the operations necessary to carry out the various computations involved in the solution. From the very nature of the case, the foundation must be experimental, and the experiments of Froude have long served as the general foundation for various methods of computation involving the use of formulæ and tables giving values of various empirical factors. It is with a view of substituting for these numerical operations the mechanical operation of the slide rule, with its well-known saving of time and mental effort, that the author has brought out this special form of computer. By its means the various dimensions and proportions of propellers—diameter, pitch, revolutions, surface, efficiency, and slip—may be quickly determined and with the same degree of accuracy as inheres in the use of the fundamental experiments by Froude and others. Regarding the question of accuracy or reliability, the general use during the past fifteen years of these experiments, with the satisfactory results which they have given, has proven the general applicability to such cases as arise in the various classes of service, naval, mercantile, and pleasure. The purpose of the computer is, therefore, to substitute for the arithmetical computations the use of the slide rule, and to reproduce in this way the results which, by numerical work, would result from the use of the various equations and formulæ which have been proposed.

In addition to the various slide-rule scales by means of which the computations are effected, and regarding the use of which full instructions are given on the inside cover of the case, the explanatory text of 52 pages gives a brief and succinct discussion of the problem of resistance and propulsion, especially from the point of view of propeller design and analysis. Resistance, race rotation, cavitation, the wake, augmentation of resistance, effective horse power, thrust horse power, propeller horse power, indicated horse power, true and apparent propeller efficiency, propulsive coefficient, mechanical efficiency of engine—these and collateral topics are briefly discussed and their relations to the main problem developed, with a number of illustrative examples.

This computer should prove a most acceptable addition to the office equipment of the naval architect or marine engineer, as by its use he will be able to save the time involved in many tedious computations and arrive quickly at the results desired. In this connection a further point of importance may be noted. This is, that with the slide-rule scales there is presented to the eye not only the actual solution desired, but the ready determination of the results due to slight departures from the original conditions. In this manner the consequences of any slight variation from the original conditions are readily observed.

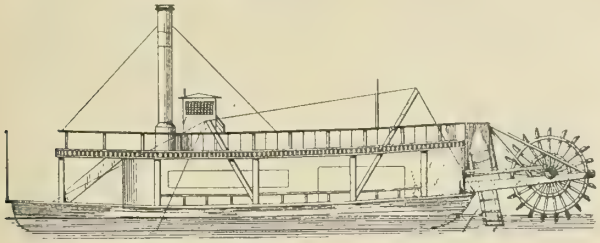
MCDERMOTT'S PROPELLER COMPUTER.

Mechanically, this computer seems to be most carefully and accurately made; the engraving is clear and well executed, and the printing, binding, and entire make-up of the computer and explanatory text leave nothing to be desired.

Speed of Warships.—An opportunity was given in the assembling of the United States squadrons in the Caribbean Sea for a test of speed of several of the warships. On November 15 the four battleships, the *Alabama, Kearsarge, Massachusetts, Indiana,* and the gunboat *Machias* sailed from Hampton Roads under orders to proceed at full speed to Culebra Light. The *Alabama* led the squadron of battleships the entire distance, and her strongest competitors were the *Massachusetts* and *Kearsarge.* After four hours the *Alabama* left the *Kearsarge* hull down, and a little later the *Massachusetts* was left behind. The cruiser *Cincinnati* started thirty-five miles behind the squadron, and came up with the *Alabama* on the second day out. The two vessels had a close race for over two days and arrived at the Light with the *Alabama* leading by two miles. Under natural draft her average speed had been 15.2, and under forced draft for four hours 16.65 knots.

SELECTED MARINE PATENTS.

713,063. STEERING AND MANŒUVERING WHEEL FOR VESSELS. SAMUEL W. COFLIN, COVINGTON, KY., ASSIGNOR OF NINE-TENTHS TO OSCAR J. COFLIN, COVINGTON, KY.



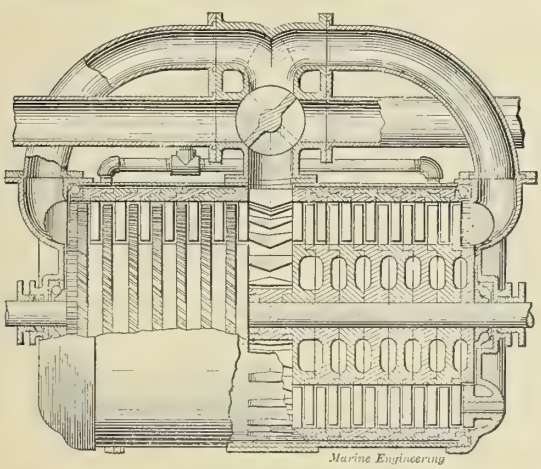
Claim.—1. A steering wheel for a vessel, consisting of paddles carried on a shaft and supported so as to be capable of rotation at right angles to the direction in which the vessel travels when moved by the means provided for its propulsion, said shaft inclined with reference to the hull of the vessel and the outer edges of the paddles inclined with reference to the shaft, and means for rotating this steering wheel and for controlling its operation. Three claims.

713,095. STEAM TURBINE. JOHN A. HELLWEG, MILWAUKEE, WIS. Four claims.

713,198. TORPEDO BOAT. FRANCIS W. BRADY, ENGLEWOOD, N. J., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

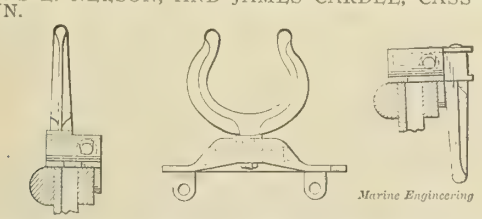
Claim.—1. A means for controlling the expulsion of torpedoes, comprising an expulsion tube, a cap which closes the outboard end of said tube, means for operating said cap, a firing valve or mechanism for controlling the expulsion of the torpedo, an automatic lock to prevent the operation of said firing mechanism, and means controlled by the cap-opening mechanism which sets the said lock so that it may be operated to unlock the firing mechanism. Seven claims.

713,261. STEAM TURBINE. MORRIS M. WHITAKER, SACKETT HARBOR, N. Y., ASSIGNOR OF ONE-HALF TO WILLIAM R. SANDS, NEWARK, N. J.



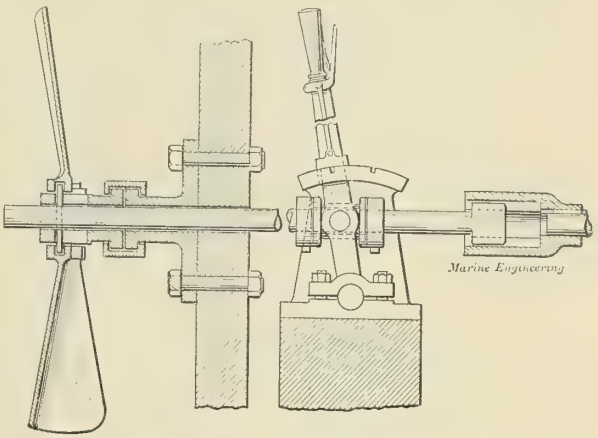
Claim.—1. In a turbine the combination with a casing having inlet and outlet passages, and a shaft journaled in the casing, of a revoluble core mounted on the shaft having blades arranged at an angle thereto, a drum journaled in the casing surrounding the core and provided with blades extending between those upon the core and extending at an angle to said blades, gear wheels upon the revoluble parts and pinions arranged within the casing and between said parts. Sixteen claims.

713,551. FOLDING OAR LOCK. JOHN M. BIRTELS, CASS LAKE, MINN., ASSIGNOR TO MICHAEL L. TOOLE, JACOB E. JOHNSTON, ANNA KENNEDY, JAMES E. NELSON, AND JAMES CARDLE, CASS LAKE, MINN.



Claim.—1. In a folding oar lock, a supporting base having a hollow upwardly-projecting central portion with a transverse opening through its top and one side, a block projecting through said transverse opening and having lateral studs engaging the interior of said central projecting portion and affording partial support to said block, a pivotal pin passing through said studs and said block and secured by its ends in said projecting portion, and an oar lock pivotally secured in said block. Three claims.

713,441. PROPELLER. SAMUEL IRWIN, LINDSAY, CANADA.



Claim.—1. The combination of a box, a hub juxtaposed thereto, said parts being formed with annular flanges, a collar enclosing said flanges rotatably to connect the hub to the box; propeller blades adjustably mounted on the hub, a shaft longitudinally movable through the box and hub, and a connection between the shaft and the propeller blades. Three claims.

713,454. MARINE VESSEL. FREDERICK A. KNAPP, PRESCOTT, CANADA.

Claim.—1. In a marine vessel, the combination of a central tube; an inner skin; and an outer skin suitably connected and arranged to form an annular air space between the two skins and annular cargo space between the inner skin and the central tube. Seven claims.

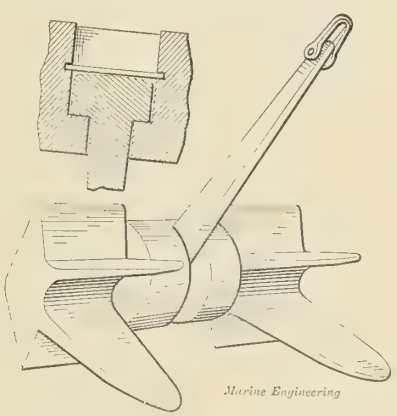
713,651. BALLAST-UNLOADER. GEORGE W. KING, MARION, OHIO, ASSIGNOR TO THE MARION STEAM SHOVEL COMPANY, MARION, OHIO, A CORPORATION OF OHIO. Nine claims.

713,785. MARINE PROPULSION. OLUF E. MEYER, MILWAUKEE, WIS.

Claim.—1. In a marine propeller, cranked shafts secured in bearings at either side of a vessel and parallel with the keel thereof, spiral blades having a plurality of turns throughout the length of said shafts and secured to the latter, openings in the sides of the vessel below the water line thereof and opposite the cranks in the aforesaid shaft. Three claims.

713,797. DETACHABLE DECK FOR MARINE VESSELS. JOSEPH W. POWELL, FARNHAMVILLE, IOWA. Three claims.

713,825. ANCHOR. JOHN WICK, CHESTER, PA., ASSIGNOR OF ONE-HALF TO WILLIAM P. TODD, CHESTER, PA.



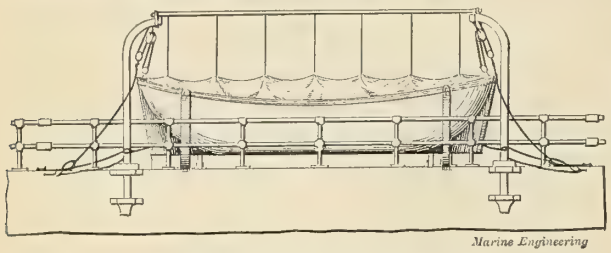
Claim.—1. An anchor comprising a shank and a head or body pivotally connected with the shank and capable of a limited rotary movement, said head or body being provided at each side with a pair of diverging flukes arranged to be carried to either side of the shank by the said rotary movement, whereby one fluke of each pair will embed itself in the bottom and the other fluke will lie upon the surface of the bottom, substantially as described. Five claims.

713,830. BOAT. SYLVESTER S. YORK, PORTLAND, ME., ASSIGNOR OF ONE-HALF TO CHARLES W. YORK, EAST BOSTON, MASS.

Claim.—1. A boat provided with a keel board pivoted on a longitudinal axis and extending on both sides thereof and weighted to bring its center of gravity below its pivot, and means for positively moving said board into different angular positions.

2. A boat having a recessed keel and provided with a keel board, said keel board being pivoted on a longitudinal axis within said recess and extending on both sides of said axis and weighted to bring its center of gravity below its pivot, said board being adapted to lie with its edges either at equal or at different elevations with respect to the boat hull.

713,889. APPARATUS FOR LOWERING LIFE BOATS. ANTONIO KERSUL, NEW YORK, N. Y.

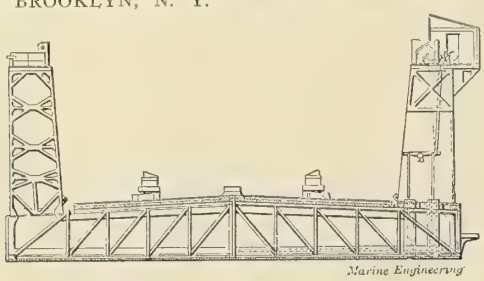


Marine Engineering

Claim.—1. An apparatus for lowering life boats, consisting of two rotatable davits, a drum on each davit, means for supporting the boat on the deck of the vessel, a lowering rope or fall connected with each davit and with the boat, and a davit rope for each davit passing over the drum of the same and connected with a bight of said lowering rope. Seven claims.

713,920. TURBINE. JAN PROCNER, PABIANICE, NEAR LODZ, RUSSIA. Three claims.

713,947. FLOATING DRY-DOCK. GASTON A. BRONDER, BROOKLYN, N. Y.



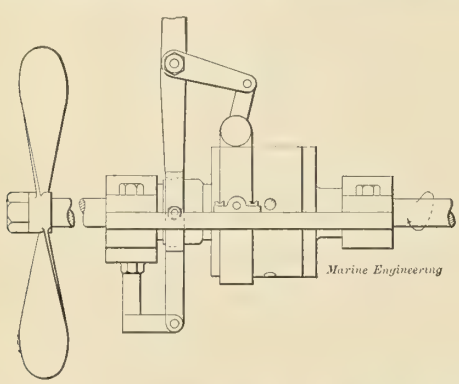
Marine Engineering

Claim.—1. A pontoon consisting of the combination of a metallic framework, wooden stringers bolted thereto constituting a wooden frame on the outside of the steel framework, planking spiked to said stringers, and means for compressing the planks against each other.

2. In a pontoon consisting of steel frames, a wooden frame bolted on the outside of the steel frames, planking spiked to the wooden frame, gutters taking the place of some of the planking and bolted to the pontoon. Five claims.

714,193. BALLAST UNLOADER. GEORGE W. KING, MARION, OHIO, ASSIGNOR TO THE MARION STEAM SHOVEL COMPANY, MARION, OHIO, A CORPORATION OF OHIO. Eight claims.

714,197. REVERSING GEAR FOR PROPELLER SHAFTS. ALBERT L. KULL, CAMDEN, N. J.



Marine Engineering

Claim.—1. In a reversing gear, a divided shaft, gears mounted on the abutting ends of said divided shaft, gears meshing at right angles with the shaft gears, a housing enclosing all of said gears and forming a pivotal support for the meshing gears, said housing and meshing gears normally rotating around the shaft gears, a band having a cam surface, a bolt having a cam-shaped head adapted to engage said cam surface to clamp said band to said housing for breaking the rotary movement of the housing whereby the motion of one shaft gear may be transmitted through the meshing gears to the other shaft gear to turn said gear in an opposite direction, and means for locking one abutting end of the shaft directly to the housing when said housing normally rotates. Four claims.

714,499. APPARATUS FOR COALING SHIPS. FREDERICK V. MATTON, CAMDEN, N. J. Two claims.

714,627. STEAM TURBINE. ROBERT WILSON, SCHENECTADY, N. Y. Two claims.

714,757. LIFE-SAVING APPARATUS. JOHN STRAKELE, NEW YORK, N. Y., ASSIGNOR OF ONE-THIRD TO JOHANN MARTIN SCHWENK, NEW YORK, N. Y. Six claims.

714,766. CONVERTIBLE BOAT-PROPELLING APPARATUS. JAMES WHITESIDE, NEW YORK, N. Y. Two claims.

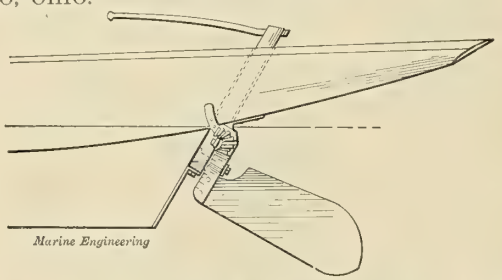
714,921. STORAGE OF SUPPLIES FOR SUBMARINE VESSELS. SIMON LAKE, BRIDGEPORT, CONN. Seven claims.

Claim.—1. A submarine boat comprising a hull shaped to resist the external water pressure during submergence and means for closing the same water-tight from the exterior, means for propelling the same including a heat engine, a fuel tank or reservoir carried by said boat exterior to and upon the upper side of the said hull, and a connection from said fuel tank or reservoir through the wall of the hull to the said heat engine. Seven claims.

715,013. PROCESS OF TREATING THE OUTSIDES OF SHIPS, ETC., FOR MAKING THEM LESS VISIBLE. GEROME BRUSH AND ABBOTT H. THAYER, DUBLIN, N. H.

Claim.—1. The method of making an object less visible, which consists in giving to that part of the surface of the object which would reflect the most light a comparatively dark color and to that part which would reflect the least light a comparatively light color, so as to prevent the existence of contrasts of light and shade. Three claims.

715,176. YACHT RUDDER. GEORGE W. SWAN, TOLEDO, OHIO.

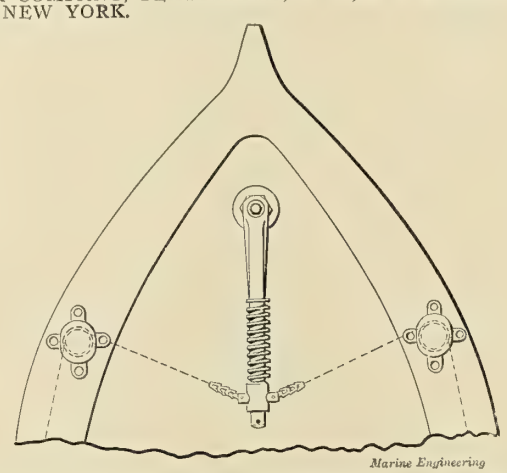


Marine Engineering

Claim.—1. In a rudder, the combination with the rudder post, of a rudder blade pivoted thereto at an angle to the axis thereof, and means for turning the rudder blade upon its angular axis, simultaneously with the turning of the rudder post.

2. A rudder for sail yachts comprising a rudder post, a rudder blade pivoted at the lower end of the post, a segmental gear upon the blade, and a segmental gear secured upon the hull of the yacht adapted to engage the gear upon the blade, as shown.

715,193. STEERING GEAR. GEORGE A. BURWELL, PLATTSBURG, N. Y., ASSIGNOR TO THE LOZIER MOTOR COMPANY, PLATTSBURG, N. Y., A CORPORATION OF NEW YORK.



Marine Engineering

Claim.—1. In a vessel, the combination with a tiller and steering chains, of a coiled spring mounted on said tiller and having one end fixed to said tiller, the other end being in operative relation with said steering chains.

2. In a vessel, the combination with a tiller and steering-chains, of a coiled spring mounted on said tiller and having one end fixed to said tiller, and a sleeve loosely mounted upon said tiller and in operative relation with said spring and steering chains.

715,191. DUPLEX PROPELLER. HUGH B. ALLISON, DES MOINES, IOWA.